PROCEEDINGS

OF THE

BOARD OF AGRICULTURE IN INDIA

HELD AT

PUSA

ON THE

20th November 1911, and following days,

WITH APPENDICES.

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BOARD OF AGRICULTURE, NOVEMBER 1911.

No. 1427.

FROM

BERNARD COVENTRY, Esq.,
Offg. Inspector General of Agriculture in India,

To

THE SECRETARY TO THE GOVERNMENT OF INDIA,
DEPARTMENT OF REVENUE AND AGRICULTURE,
SIMLA.

PUSA, *the 16th December, 1911.*

SIR,

I have the honour to submit the Proceedings of the Seventh Meeting of the Board of Agriculture in India, held at Pusa on the 20th November, 1911, and subsequent days. These Proceedings have been recorded by Mr. A. C. Dobbs, Assistant Inspector General of Agriculture in India, who acted as Secretary. The Proceedings have been approved by the Board.

I have the honour to be,

SIR,

Your most obedient Servant,

BERNARD COVENTRY,
Offg. Inspector General of Agriculture in India.

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The Seventh Meeting of the Board of Agriculture in India.

INTRODUCTORY.

1. The Seventh Meeting of the Board of Agriculture in India was held at Pusa on the 20th November, 1911 and following days under the presidency of Mr. B. Coventry, Offg. Inspector General of Agriculture in India.

Members.

The members present were :—

1. Bernard Coventry, Offg. Inspector General of Agriculture in India. (President.)
2. A. C. Dobbs, B.A., Assistant Inspector General of Agriculture in India. (Secretary.)
3. E. J. Butler, M.B., F.L.S., Offg. Director, Agricultural Research Institute, and Principal of College, Pusa.
4. G. A. Gammie, F.L.S., Imperial Cotton Specialist.
5. J. W. Leather, Ph.D., F.I.C., F.C.S., Imperial Agricultural Chemist, Pusa.
6. T. Bainbrigge Fletcher, R.N., F.E.S., F.Z.S., Imperial Entomologist, Pusa.
7. A. Howard, M.A., A.R.C.S., F.L.S., Imperial Economic Botanist, Pusa.
8. C. M. Hutchinson, B.A., Imperial Agricultural Bacteriologist, Pusa.
9. W. B. Heycock, I.C.S., Director of Agriculture, Bengal.
10. F. Smith, B.A., F.H.A.S., Deputy Director of Agriculture, Bengal.
11. E. J. Woodhouse, B.A., Principal, Agricultural College, Sabour (Bhagalpur), Bengal.
12. E. A. Molony, I.C.S., Director of Land Records and Agriculture, United Provinces of Agra and Oudh.
13. B. C. Burt, B.Sc., F.C.S., Deputy Director of Agriculture, United Provinces of Agra and Oudh.
14. G. Clarke, F.I.C., Agricultural Chemist, United Provinces of Agra and Oudh.
15. W. S. Hamilton, B.A., I.C.S., Director of Agriculture and Industries, Punjab.
16. J. H. Barnes, B.Sc., F.I.C., F.C.S., A.R.I.P.H., Principal, Agricultural College, Lyallpur.
17. S. Milligan, M.A., B.Sc., Deputy Director of Agriculture, Punjab.
18. T. F. Main, B.Sc., Deputy Director of Agriculture, Bombay, Poona.
19. H. H. Mann, D.Sc., Principal, Agricultural College, Poona.
20. G. A. D. Stuart, I.C.S., Director of Agriculture, Madras.
21. H. C. Sampson, B.Sc., F.H.A.S., F.B.S.E., Deputy Director of Agriculture, Southern Division, Madras.
22. C. A. Barber, M.A., D.Sc., F.L.S., Economic Botanist, Madras.
23. D. Clouston, M.A., B.Sc., Deputy Director of Agriculture, Southern Circle, Central Provinces.
24. G. Evans, B.A., Deputy Director of Agriculture, Northern Circle, Central Provinces.
25. A. McKerral, M.A., B.Sc., Deputy Director of Agriculture, Burma.
26. S. G. Hart, I.C.S., Director of Agriculture, Eastern Bengal and Assam.
27. A. G. Birt, B.Sc., Deputy Director of Agriculture, Eastern Bengal and Assam.

28. A. A. Meggitt, B.Sc., Agricultural Chemist, Eastern Bengal and Assam.
29. L. C. Coleman, M.A., Ph.D., Mycologist and Entomologist to the Government of Mysore.

VISITORS.

2. In addition, the following attended as visitors :—

1. The Hon'ble Mr. (now Sir) R. W. Carlyle, C.S.I., C.I.E., I.C.S., Member in charge of the Department of Revenue and Agriculture, Government of India.
2. The Hon'ble Mr. W. H. Clark, C.M.G., Member in charge of the Department of Commerce and Industry, Government of India.
3. W. H. Moreland, C.I.E., I.C.S., Officer on Special Duty with the Government of the United Provinces of Agra and Oudh.
4. H. C. Streatfield, I.C.S., Commissioner, Tirhoot Division.
5. A. E. Scroope, I.C.S., Collector of Darbhanga.
6. T. Luby, I.C.S., Sub-Divisional Officer, Samastipur.
7. F. M. Howlett, B.A., Second Imperial Entomologist, Pusa.
8. H. E. Annett, B.Sc., F.C.S., M.S.E.A.C., Supernumerary Agricultural Chemist, Pusa.
9. F. J. F. Shaw, B.Sc., A.R.C.S., Supernumerary Mycologist, Pusa.
10. A. J. Grove, M.Sc., Supernumerary Entomologist, Pusa.
11. (Mrs.) G. L. C. Howard, M.A., Personal Assistant to the Imperial Economic Botanist, Pusa.
12. C. Somers Taylor, B.A., Agricultural Chemist, Bengal.
13. G. C. Sherrard, B.A., Professor of Agriculture, Agricultural College, Sabour (Bhagalpore), Bengal.
14. P. C. Patil, L. Ag., Divisional Inspector, Bombay Presidency, Central Division, Poona.
15. J. M. Lonsdale, N. D. A., N.D.D., Agricultural Expert for Court of Wards, Madras.
16. R. G. Allan, M.A., Principal, Agricultural College, Nagpur.
17. F. J. Plymen, A.C.G.I., Agricultural Chemist, Central Provinces.
18. Tundilal Powar, B.A., Superintendent of Demonstration, Chhattisgarh Division, Raipur.
19. R. S. Finlow, B.Sc., F.C.S., Fibre Expert to the Government of Eastern Bengal and Assam.
20. G. P. Hector, M.A., B.Sc., Economic Botanist, Eastern Bengal and Assam.
21. Sheikh Makbul Hussain, B.A., M.R.A.C., Bar-at-Law, Revenue Minister, Jammu and Kashmir State.
22. W. Robertson-Brown, Superintendent of Farms, Peshawar.
23. R. D. Anstead, B.A., Planting Expert to the Uuited Planters' Association, South India.
24. C. J. Bergtheil, Director, Indigo Research Station, Sirseah.
25. T. R. Parnell, Botanist to Behar Indigo Planters' Association, Sirseah.
26. A. E. Slater, Agricultural Chemist, Christian College, Allahabad.
27. J. McGlashan, F.C.S., Manager, Cawnpore Sugar Works, Cawnpore.
28. G. Richardson, Bhicanpore Factory, Muzafferpore.

PROGRAMME.

SUBJECTS DISCU SED.

3. The programme before the Board consisted of the following subjects approved by the Government of India for discussion :—

I.—The Confirmation of the Proceedings of the last Meeting.

II.—The Programme of Work of the Imperial Department of Agriculture.

III.—The Programmes of Work of the Provincial and Native States' Departments of Agriculture.

IV.—The best means of bringing the results of experimental work in agriculture to the notice of cultivators.

V.—Manures :—

(i) The most economical manures available in India and the experience gained in their use.

(ii) The conservation and application of cattle manure.

VI.—The Oil-pressing Industry and the best means of extending it.

VII.—The question of admitting representatives of the Press to the deliberations of the Board, or of having the proceedings reported daily by a member of the Board, subject to the censorship of the President of the Board.

VIII.—The question of granting honorary degrees of L. Ag. to such Diplomates of old Agricultural Colleges as have done or may do work of exceptional merit, and to non-officials whose interest in and services to agriculture are conspicuous.

IX.—The duties of Agricultural Associations in India.

X.—The general lines on which the organisation of scientific research in the Provincial Departments of Agriculture should be developed.

XI.—The maintenance of pure seed of improved varieties of crops.

XII.—The Indian Sugar Industry :—

(i) The improvement of the indigenous industry.

(ii) The production of the refined sugar which is now imported.

(iii) The possibility of extending the area under sugarcane in India.

XIII.—Cotton investigation in India and the Note thereon by the Inspector General of Agriculture in India.

PROCEEDINGS.

FIRST DAY.

Opening of Proceedings; President's Address.

4. In opening the Proceedings the President said :—" Gentlemen, it gives me much pleasure to welcome you all at this the Seventh Meeting of the Board of Agriculture. I feel sure that you will regret, as much as I do, the premature absence of Mr. Mollison, your former President, and the loss which the Department has suffered by his retirement. At the same time we have this much to rejoice in, in that we can congratulate Mr. Mollison on the distinction of C.S.I. which has recently been conferred upon him. I shall therefore propose that you join me in placing on the record of our Proceedings, that while regretting his absence from amongst us, we congratulate him on the acquisition of his well merited distinction and that we appreciate the valuable services he has given to the Department in the past.

" I shall also, gentlemen, propose a vote of thanks to Mr. C. M. Hutchinson for the able manner in which he performed the duties of Secretary to the Board at our last meeting."

These proposals being acclaimed the President proceeded :—

" And now for myself, gentlemen, as this is the first time I have the honour of presiding over a meeting of the Board of Agriculture, I will ask you to be good enough to extend to me the indulgence which you have formerly shown to my distinguished predecessors, and assist me to conduct our Proceedings in keeping with our best traditions.

" I have to express regret at the absence of so many former Directors of Agriculture. Of those who attended our former meetings only Mr. Moreland from the United Provinces and Mr. Hart from Eastern Bengal and Assam are with us here to-day. It cannot for a moment be doubted but that we must seriously feel the sudden deprivation of the experience and sound judgment of Messrs. Couchman, Keatinge, Renouf, McKenna and Gourlay. It is by mere good fortune that I have been able to secure the services of Mr. W. H. Moreland in spite of his being no longer Director of the United Provinces, and our thanks are due to him for having taken the trouble to attend this meeting in order to assist us in our deliberations.

" I will now, gentlemen, ask you to bear with me while I review shortly the subjects that are on the programme for discussion.

" The first is the confirmation of the proceedings of the last meeting. Before you confirm those proceedings you will be asked to consider, in the light of the experience of the past two years, whether the resolution that the meetings of the Board should be held every two years should stand. It is possible that some of you may think that two years is too long a time to wait for the decision of the Board on some important question which cannot very well be settled by any other body. Speaking for myself, though I do not wish that my views should influence you in any way, and I was one of those who originally voted for the Board to be held biennially, I may say that I feel a considerable amount of relief in the thought that I have been able to call together the present meeting some three months before its time. You will observe that there are 13 subjects down on the programme for discussion, some of which are of great importance, and the decisions on which have been waiting for weeks, and in some instances I may say for months, the advice of the Board. I have no doubt whatever but that the consideration of these 13 subjects will fully occupy your time during the next six days. But besides these 13 subjects I have on a separate list 22 items which it was found impossible to include within the agenda, as time could not possibly allow of their being considered. These 22 extra items have nearly, if not entirely all been suggested to me by the provincial agricultural departments. This shows you, gentlemen, that at any rate this year we have more than we can get through in one year. There is also the fact that the Government of India depend a great deal upon the advice of the Board on matters of policy, and especially when the subject is one where uniformity or a

combined effort at co-operation of the various agricultural departments is desired. There is also the great advantage you yourselves derive from meeting one another. Now, gentlemen, as I have already said I do not wish in the least to influence you with my personal views in arriving at a decision, but it is but right I should place the facts in front of you, and, before you confirm the proceedings of your last meeting, it is but proper, in view of the great importance and value which attach to your deliberations, that you should have the opportunity at any rate of considering in the light of experience and the probable needs of the department, whether the meetings should be held annually or biennially. Another point which you will also be asked to consider at the same time is where subsequent meetings of the Board should be held.

"The next two subjects are the programmes of the Imperial and Provincial Departments of Agriculture which will be dealt with in the usual way. We next come to Subject IV, namely, 'The best means of bringing the results of experimental work in agriculture to the notice of cultivators.' This, we might say, is the ultimate object of our existence and so important do we consider the subject that it appears permanently on every programme of the Board. It will be treated, in the usual way, by a specially appointed Committee to report to the Board the advances that have been made by the department since our last meeting.

"The next Subject, V, is entitled *Manures*. It is divided into two parts :—

(1) The most economical manures available in India and the experience gained in their use ;

(2) the conservation and application of cattle manure.

"The first half of the subject was introduced at the last meeting of the Board, but as the information then presented was too scanty to enable the Board to frame a resolution, the provincial departments were invited to supply a brief account of their experience. These have been received and summarised by Mr. A. C. Dobbs, Assistant Inspector General of Agriculture, who will present his synopsis in due course. The second half, *viz.*, 'the conservation and application of cattle manure,' has been added this year as likely to increase the importance of the general discussion. It must be admitted that the conservation and application of cattle manure (in which should be included all kinds of organic matter in the way of straw and rubbish which goes to make a manure heap) is a subject of the utmost importance to this country. We know that a very large amount is wasted. If all this wasted manure and organic rubbish were applied to the crops and if we suppose the modest figure of Re. 1 per acre to be the value of the increase due to its application to agricultural land, the country would be the richer by some £20,000,000 per annum. I mention this to show you the really important aspect of this problem and the value of cattle not only for draught and milk purposes but as the great producers of plant food. I have no doubt we shall be able to devise means to stop the great waste of manure with the same success as we are experiencing in the introduction of other improvements.

"The next Subject, No. VI on the agenda sheet is—'The Oil-pressing Industry and the best means of extending it.' This too was before your last meeting, but its consideration was postponed for the purpose of gathering information from various local departments. This has been done and the notes have been collated by Mr. Burkill.

"The question of having the Proceedings of the Board supplied to the press forms Subject VII. It has been long felt that the delay which occurs in publishing the Proceedings of the Board, in some years extending to many months after the meeting, does not satisfy the press and the public, which in these days abhor, and quite rightly, the issue of belated reports. And moreover it is a fact that a large proportion of the educated public either do not know or, if they do know, do not fully realise the important work the department is doing, and is often not interested to that degree which might be expected, considering the beneficial and productive character of our undertakings. The fault is not entirely ours, for they have only to read the annual reports and other publications of the department to learn what we are doing. Nevertheless I have no doubt, you will agree with me, that it is our duty as well as to our advantage to enlist the co-operation of the press and to acquaint the public as promptly as is possible and do all

we can to foster interest in our Proceedings. *It has therefore been decided by Government that you should consider whether the deliberations of the Board* could not, while we are sitting, be made public under reasonable control.

"The next Subject, No. VIII is—'*The question of granting honorary degrees* of L. Ag. to Diplomates of old Agricultural Colleges who have done or may do work of exceptional merit, and to non-officials whose interest in and services to agriculture are conspicuous.' This question was originally brought into prominence by the Government of the United Provinces which desired to grant these honorary degrees. The point was referred to Local Governments by the Government of India, but as there is some diversity of opinion amongst them and as the importance of arriving at a correct decision is fully recognised, the question has been referred to you for opinion and advice.

"We now come to Subject, No. IX—'The duties of Agricultural Associations in India.' Though this subject can very well be considered along with Subject IV, I have given it a separate place on the agenda sheet in order to emphasize its importance and to obtain from you a well defined statement of your advice. In my tours throughout India I have been struck by the immense amount of energy which is displayed in the efforts of the Divisional and District Agricultural Associations. Not only do I refer to the energy of the members themselves who represent the land-holding communities both Indian and European, but there is the assistance given by the members of the Indian Civil Service in the persons of Commissioners of Divisions, Collectors of Districts, Sub-Divisional officers and the like, who preside over their meetings, devote much of their time and take great personal interest in the work. But, gentlemen, if I have been struck with the edifying spectacle of so much effort displayed in such a noble cause as the improvement of the agriculture of the country, I have been equally impressed with the way in which all this energy is oftentimes wasted and misdirected. You will find if you go into the matter that in the Madras Presidency, for example, the Agricultural Associations are declared to be of no use whatever. In other provinces too, which I need not name, *there is much waste of time spent in so-called experimenting, in which the* only aim and object appear to be to show results per acre over small areas, rather *than demonstrate the improvements of the Agricultural Departments over large* areas. You will find too in many instances that the members consist of people who have little or no direct connection with the land, but whose objects appear to be to gain *kudos* of some sort by aiding agriculture. As a contrary example to all this we find, in the Central Provinces, that the officers of the Department cannot speak too highly of the utility of the Agricultural Associations of those provinces. This gives us hope that, perhaps, by following the example of the Central Provinces, other provinces that are backward in this respect may improve themselves. By laying down the conditions that make for the successful working of Agricultural Associations for the guidance of those concerned, the Board will prevent the valuable energy I have described from being wasted, and will help to conduct into the right paths those forces which should be the most sure and powerful means of bringing home to cultivators the improvements of the Department.

"The next subject on the programme, Subject X, is—'The general lines on which the organisation of scientific research in the provincial departments should be developed.' A want has been felt in some provinces for a more definite statement than at present exists of the lines on which scientific research and experiment should be carried out and the relations that should obtain between different scientific officers, as for example, between the Botanist and the Deputy Director in the improvement and development of a particular plant. Under some circumstances, and indeed in most circumstances in my experience, it has usually been found advisable to let scientific officers settle these questions very much in their own way, *but where this is not possible some rules, or I should rather say suggestions, are* required on the subject. While these suggestions will have no binding force, yet the opinion and advice of the Board on an important question of this kind will, without doubt, receive due recognition.

"Subject, XI is—'The maintenance of pure seed of improved varieties of crops.' Gentlemen, there are few subjects so important as this. In this country where a well bred thing, whether animal or vegetable, soon begins to degenerate, and where the evil of sowing mixed seed is the established custom, the maintenance of pure seed of an improved plant is a matter of the utmost concern. In Europe

and America you have your Sutton & Sons, your Garton Brothers and your Peter Hendersons, firms of high repute who are both plant breeders and seed suppliers and whose names are a guarantee of reliability. But what organisation have we in India for the maintenance of a supply in quantity of pure seed of improved varieties of crops? Indeed we have none at all. If there is one aspect of our work where success is assured, it is in the improvement of the plant. There is scarcely a crop in India whose plant is not an inferior or degenerated specimen. If the Botanist improves it both in respect of yield and quality and the Deputy Director spreads it far afield amongst the cultivators in his province, you have introduced a valuable improvement which has cost the cultivator nothing.

"You cannot say that with reference to other improvements. As a rule capital is required with which to buy a new reaper or for the purchase of artificial manures or a whole monsoon crop has to be sacrificed in order to make room for the application of green manuring. But in the introduction of a new plant practically no increased expenditure is required on the part of the cultivator beyond the *nominal charge for the improved seed.* But how is the benefit of such an improvement to be maintained? This is the important problem which you are asked to solve at the meeting of this Board. Remember that all the work of our Botanists and Agriculturists in the improvement of crops will be in vain if we are not able to devise, organise and maintain the practical means of supplying pure seed.

"And now, gentlemen, we come to, perhaps at the present moment, the most important subject for the consideration of this Board, namely—the Indian Sugar Industry, how to improve it, how to produce the refined sugar which is now being imported and how we are to extend the area under sugarcane in India. Much has been written and said of late about sugar, and people have gone so far as to predict the extinction in a few years of the Indian sugar industry. Gentlemen, I am not such a pessimist. India produces and consumes over three million tons of sugar per annum. Indeed, according to the computations of some who include the production of Native States, her gross output is over four million tons. She is therefore far and away the greatest producer and consumer of sugar in the world, and it therefore at once occurs to ask what countries can possibly make such an enormous quantity. Moreover what at present she chiefly consumes is *gur* which is a mixture of crystallisable and non-crystallisable sugar, which foreign countries do not and will not produce, and she must therefore continue to produce this herself. But at the same time there are certain ominous signs in the condition of India's sugar trade which we cannot afford to ignore. With the increased facilities for cheap ocean traffic to and from all parts of the world and with the easy means of transit within herself brought about by her network of railways, India has been deprived of the natural barriers which formerly protected her primitive local industries, and consequently her sugar markets have been invaded by cheap white sugar from abroad. The imports of this white sugar have risen in the past 20 years from 80,000 tons to 700,000 tons per annum. It is not only displacing the existing indigenous white sugar, but, owing to its cheapness, the consumption of extra quantities of white sugar is encouraged, especially where the influence of Western civilisation is being most felt, and it is also being mixed with molasses and inferior *gur* and retailed as *gur*. It is thus undermining the foundations of the *gur* industry as well as of the indigenous refined product. The effect has been to cause a decline in the area under cane and a decrease in the number of sugar mills and refineries in the more important sugar tracts of India. We cannot afford to ignore these signs. If the encroachments take place in localities where the crop is vital to the welfare of the inhabitants, as is undoubtedly the case in the Unite dProvinces, we shall be justly blamed if we do not at this juncture pay attention to unmistakable warnings.

"Fortunately there are defects in our present methods which afford us a wide margin of improvement, and justify us in the belief that we have great scope in which to improve the industry. For example, our methods in manufacture are known to be wrong and wasteful. There is heavy loss in the extraction of the juice owing to the low efficiency of our mills, and there is much destruction and loss of sugar in the imperfect methods of concentrating the juice and in the wasteful and antiquated means of separating the molasses from the sugar in the making of the refined product. In our cultivation we obtain barely 15 tons of stripped cane per acre while other countries get 30 to 40 tons, and in the quality of our canes we are
... with a sucrose content of 10 per cent., when other countries will look

at nothing under 16 per cent. So, gentlemen, it is quite clear we have a very wide margin to work on by increasing the efficiency of our methods. The Government of India have recognised this and are considering the desirability of appointing an expert Sugar Engineer to tackle the problems in manufacture and help us with our mechanical difficulties. But this alone will not be sufficient. What is required is a combined and organised effort on the part of all concerned to raise the standard of production, and invite the co-operation of capital so as to drag the industry out of its wasteful and primitive methods. We have, on the Board, Agriculturists, Botanists and Chemists, members of the Agricultural Departments, but we also have present members of the sugar industry itself. It is for you therefore, gentlemen, to show how this regeneration is to be carried out and to advise Government on the policy it should adopt in order to fit this country for competition with her foreign rivals.

"The remaining subject on the programme is the question of cotton improvement. You will remember that in July 1910, a deputation composed of gentlemen representing cotton interests in England and India waited upon Lord Morley with the object of urging upon him the necessity for greater efforts being made in India in the production of cotton, and especially of long staple cotton. The matter was referred to me for advice, and, as it was not possible at the time to call the members of this Board together, I consulted such members of the department as I was able. and compiled, with the aid of the annual reports, the note which has been printed under Government orders and is placed on the table for your consideration. I explained in this note that the Agricultural Department was really doing everything that could reasonably be done for the improvement of the crop, but one of the chief points on which I laid stress was that there was not a free market and there were no proper buying agencies for long staple cotton in India, and that, so long as this condition of affairs continued, a fair price was not obtainable, and the increased production of long staple cotton could not be pressed upon the cultivator where short staple was more remunerative. I am glad now to be able to say that the establishment of buying agencies for long staple is being seriously taken up by the trade, and Mr. Arno Schmidt, Secretary to the International Federation of Master Cotton Spinners' and Manufacturers' Associations, Manchester, will shortly arrive in this country to investigate the matter. The Bombay Presidency still requires buying agencies for improved indigenous kinds and for the Egyptian and American varieties which can undoubtedly be grown in large quantities in Sind and the West Punjab. But in Madras, I am glad to say, the local mills are buying Cambodia cotton at full prices and shippers from the Liverpool trade are in the market for this variety. Improved 'Tinnevellies' are also obtaining recognition in the trade. The mills at Nagpur, I am informed, are likewise paying fair prices for *Buri* cotton. There are thus pleasing signs that the trade is waking up to the desirability of meeting the efforts of the Agricultural Department, and of paying a fair price for improved cotton. But still it remains to be seen how far these better market conditions will justify any radical change in the methods of cultivation existing in most cotton tracts, for we cannot advise the cultivator to do a thing that will not pay. In considering these questions and the note referred to, you will be asked to make such recommendations as you think proper.

"We will now proceed, gentlemen, to the consideration of the confirmation of the Proceedings of our last meeting, to appoint Committees, and prepare the references to the Committees on the various subjects for discussion."

SUBJECT I.—CONFIRMATION OF PROCEEDINGS OF THE LAST MEETING.

5. The President then put the question whether the Proceedings of the meeting of the Board held at Pusa on the 21st February, 1910 and the following days should be confirmed, with special reference to the final resolution, that meetings should in future be held every alternate year instead of annually. A vote was taken. **"The Board confirmed the Proceedings of the 1910 meeting."**

Proceeding to discuss whether meetings should in future always be held at Pusa, **the Board unanimously agreed to a resolution** proposed by Dr. Butler and seconded by Mr. Burt :—**"That future meetings of the Board should be held alternately in one of the Provinces and Pusa."**

Subject VII.—Reporting of the Proceedings to the Press.

6. Subject VII was then taken up. Dr. Mann, asked by the President to express his views, referred to the advantage of giving the public an idea of what the department was doing, and said he felt strongly on the subject. He proposed and Mr. Barnes seconded, **a resolution** which **was unanimously adopted by the Board. "That a Resumé of each day's Proceedings should be made by a member of the Board, and sent, after approval by the Inspector General of Agriculture, to the principal Indian papers."**

Appointment of Committees.

7. Committees were then appointed to deal with Subjects II, III, IV, V, IX, X, XI, XII and XIII of the programme, and the Board proceeded to discuss Subject VIII.

Subject VIII.—Granting of Honorary Degrees of L. Ag.

8. Mr. Molony, at the President's request, explained that it was felt that the position of some of the existing members of the United Provinces Service, who passed through the Agricultural School before the three years diploma course was introduced, was prejudiced by the subsequent creation of this course, and suggested that useful practical work done by such students in the past, should be recognised in the manner proposed.

Mr. Howard thought that promotion should depend entirely on merit, and not on degrees, and suggested that some other title might be given, so as to draw a clear distinction between the two classes of men.

Mr. B. C. Burt, in advocating the giving of such degrees, suggested that the matter, which first arose in connection with one of his assistants, did not involve any question of promotion.

Dr. Butler supported Mr. Howard and deprecated the idea that a degree should be regarded as a stamp of merit.

Mr. Barnes agreed, and pointed out that a diploma was not strictly a degree but a certificate of having passed through a certain course.

Dr. Mann objected to any giving of degrees to outsiders, but sympathised with the case of students who passed through colleges at a time when there were no degrees to obtain, and suggested a single test examination. He proposed the reference of the question to a small committee; but, the Board not approving this proposal and being clearly adverse to the granting of the proposed degrees, Mr. Molony did not press for further consideration of the subject. **"The proposal to grant Honorary Degrees of L. Ag. was** therefore **negatived."**

SECOND AND THIRD DAYS.

9. The second and third days of the meeting were devoted to the consideration, by the several Committees, of the subjects with which they had been appointed to deal and to the drafting of their reports.

FOURTH DAY.

10. The Committees appointed to deal with subjects II, III, XIII, V and VI presented their reports in the order shown.

The Committee on subjects II and III consisted of Mr. G. A. D. Stuart (Chairman), Dr. Butler, Messrs. Allan, Birt, Dobbs and Sampson.

SUBJECT II.—PROGRAMME OF THE IMPERIAL DEPARTMENT OF AGRICULTURE (APPENDIX A, PAGE 35).

The terms of reference as regards Subject II were :—

(a) *To examine how far the programmes of the several sections of the Pusa Institute meet the requirements of the Provinces and of the other sections.*

(b) *To consider whether any modification in the programme of the Agricultural section is desirable.*

Mr. Stuart read the report.

Mr. Sampson proposed and Mr. Heycock seconded that the report be accepted.

After some preliminary discussion as to the Committee's recommendation with regard to feeding stuffs, during which Dr. Leather explained the time-absorbing nature of such experiments, Mr. Howard proposed the exclusion of the question as not likely to arise in practice in India. Mr. Hart seconded this proposal but it was rejected by the Board.

After some further discussion **"the report as given below was accepted by the Board."**

1. *Programme of the Director of the Institute.*—The Committee are of opinion that the word " Breeding and " in the second line of the second paragraph of the programme should be omitted.
2. *Programmes of the Agricultural Chemist, Economic Botanist, Mycologist, Entomologists and Agricultural Bacteriologist.*—The programmes are approved.
3. *Programme of the Agricultural Section.*—The Committee regret that it has not been found possible to include in the programme items of work which would be of more value to provincial departments, *e.g.*, testing and trial of agricultural and dairy machinery, and the relative feeding value of bulky and concentrated food-stuffs for draught and milch cattle and for young stock.
4. *Programme of the Imperial Cotton Specialist.*—The programme is approved.

11. Mr. Barnes then proposed and Mr. Milligan seconded a resolution "that the relative feeding value of food-stuffs and fodders for cattle is of such importance to the whole of Indian agriculture that the Board recommend an early study of the subject."

Dr. Leather proposed and Mr. McKerral seconded an amendment "that in the opinion of the Board the subject of the relative value of feeding stuffs should be brought up for detailed consideration at the next meeting of the Board."

Mr. Annett said he thought the question needed a very large amount of consideration in view of the number of cattle required and the expense.

Mr. Milligan deprecated the postponement of an important subject for these reasons.

After some further discussion of the difficulties, during which Dr. Leather pointed out the necessity of securing continuity of the work and the difficulty of doing so, the amendment was rejected.

Mr. Barnes, in reply to a question where he proposed the work should be started suggested its starting at Pusa, and that collaboration with the provinces should be introduced as occasion arose.

Mr. Clouston thought the question of fodder was a local one.

Mr. Milligan said the most important part of the question was the value of concentrated feeding stuffs like cakes, and Mr. Burt suggested that this could be tested by simple experiment on provincial farms.

Mr. Stuart then proposed and Mr. A. G. Birt seconded that the words "at Pusa" should be added. The proposal was put to the Board and carried, and **the resolution**, which now ran **"That the relative feeding value of food-stuffs and fodders for cattle is of such importance to the whole of Indian Agriculture that the Board recommend an early study of the subject at Pusa" was then passed.**

Subject III.—Programmes of Provincial and Native States' Departments of Agriculture (Appendix B, page 38).

12. As regards Subject III, the terms of reference were :—

(*a*) *To consider how far the programmes of the several Provincial and Native States' Departments meet the requirements of the Imperial Experts and of the other Provinces and States.*

(*b*) *To examine and report how far the recommendations of Committee A of the Board of* 1910, *printed on page* 80 *of the proceedings and passed by the Board, have been followed in drawing up the programmes.*

The text of the report is as follows :—

(*a*) The programmes were considered in detail and were accepted.

(*b*) The Committee observe that the programmes of the following Provinces and States have not followed the recommendations of Committee A of the Board of 1910, which were approved by the Board, in respect to the following points :—

(1) *United Provinces.*—There is no clear presentation of the work in progress and of its relation to past and future work.

(2) *Burma, Sections I, IV and V.*—There is a lack of reference to past work.

(3) *Central Provinces and Berar.*—Separate programmes by the individual provincial officers have not been prepared.

(4) *Baroda.*—The information given is not sufficient to enable the Committee to form an adequate idea of the character of the work being done.

With reference to the United Provinces programme, Mr. Moreland explained that owing to the early meeting of the Board, it had been necessary to print the programme as it stood in order to avoid delay in its submission.

The report was then **accepted** without further discussion.

Subject XIII.—Cotton Investigation.

13. The Committee on Subject XIII consisted of Mr. Gammie (Chairman), Messrs. Clouston, Hart, Main, Milligan and Sampson.

The terms of reference were :—

To consider the note on cotton investigation by the Officiating Inspector General of Agriculture in India and to make recommendations on the best means of aiding the cultivation of cotton in India.*

Mr. Gammie read the report.

Mr. Evans suggested that the exceptions in the 4th paragraph included the whole cotton-growing area of India, and Mr. Burt having questioned the accuracy of saying definitely that any part of the United Provinces was suitable for the extension of the American type of cotton, the Board agreed to accept the substitution by the Committee of a better definition of the places suitable to this type.

The report as thus amended is as follows :—

The Committee agree with the note of Mr. Coventry which shows fully the present condition of cotton cultivation in India, and the following remarks are offered with a view to emphasise the essential principles affecting the extension and improvement of Indian cotton. The work already accomplished by the Agricultural Department is summarised by Mr. Coventry on page 1.

(1) *The survey of indigenous varieties* has been practically completed.

(2) *The selection and distribution of seed.*

Each province concerned has worked out the lines of selection which are considered most profitable to itself and is now engaged in devising workable schemes for the maintenance of the selected types, mainly by the distribution of seed through seed farms. By continuous effort in this direction it will be possible, in time, to establish pure and selected strains over large areas.

The trials with American and Egyptian cottons in the tracts found suitable to them should be persevered with, and, as it is unfortunately the case that these cottons promise best in originally dry tracts of the country now brought under irrigation and where cotton cultivation is not seen at its best, it is absolutely essential that their introduction should be accompanied by a method of cultivation far superior to that practised at present.

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* Published as Bulletin No. 36 of the Agricultural Research Institute, Pusa.

Work with this object in view is being carried out in Sind and the Panjab. The most suitable type of American cotton to introduce into these provinces would be an early maturing variety, even supposing something was sacrificed in the way of quality though not in outturn. Unless this can be obtained, there does not seem much chance of American cotton being taken up by the people to any great extent.

With the exception of the areas mentioned in Mr. Coventry's report, there seem to be no other large tracts in India suitable for the cultivation of American cottons and in most of these its extension would depend on facilities for irrigation and drainage.

The introduction of irrigated exotic cottons would mean an increase in the area and output; Mr. Coventry has pointed out that the increase or decrease of total cotton area is purely an economic question. Many attempts at the introduction of indigenous varieties from one tract to another have been made, but with the exception of the successes mentioned by Mr. Coventry all have failed.

The general adoption of improved methods of cultivation, especially those directed to obtaining and maintaining due cleanliness of the land, will have more effect in increasing the output over vast tracts of the cotton areas which are at present in a foul condition, than perhaps any other method we can suggest.

All provinces recognise the fact that a great improvement can be effected by the distribution of seed of pure strains to cultivators. In some cases these strains by no means give the best staple from a manufacturer's point of view but, owing to their hardiness, high yield and high percentage of cotton to seed, the cultivators find these most profitable to grow, and unless a greater distinction in price is made between high and low grades of cotton, it will naturally follow that the hardy short staples will continue to increase, as they have done in the past, at the expense of cottons of better quality which, as a rule, are more delicate and not so prolific.

The chief obstacle which lies in the way of the improvement of the cotton staple in India is that little or no attention is paid by exporters to the actual merits of the cottons for manufacturers. This appears also in valuations received from Liverpool. The exporters in India will buy anything—good, bad or indifferent, as long as the colour and cleanliness satisfy them. On the other hand, buyers for Indian mills do appreciate quality of fibre and are willing to pay more for it, although, since there is little competition, the increased price is not in proportion to the improvement in quality. In Bombay initial steps have been taken to remedy this defect (*vide* Mr. Main's programme of work for 1912-13). Appendix B, page 43.

To conclude, we consider that the best means of aiding cotton cultivation in India have been systematically carried on from the very commencement of the operations of the present Agricultural Department, and we are supported in this conclusion by the account of work done as detailed by Mr. Coventry in his note already referred to.

The members of the Department now in charge of cotton operations will have their hands quite full enough for some years to come with the task of distributing and maintaining the improved varieties they have so far developed or introduced. In almost all instances cultivators already appreciate the good qualities of the improved types and (in the Central Provinces at least) are willingly paying enhanced rates for the seed. By unremitting attention to the selection of seed year after year, and by demonstrations of improved methods of cultivation, the general standard of the crop is certain to rise steadily, and for the immediate future, this work, accompanied by the evolution of new types by plant breeding, is all the Department can be reasonably expected to undertake.

The Board's acceptance of this report was expressed in a resolution proposed by Mr. Main and seconded by Mr. Howard. **"The Board fully agrees with the note on cotton investigation in India prepared by the Inspector General of Agriculture, and desires to emphasise the points specially insisted on in the Committee's Report."**

14. The Committee on Subjects V and VI consisted of Dr. Leather (Chairman), Dr. Mann, Messrs. Allan, Dobbs, Main, McKerral, Meggitt, Hamilton, Hutchinson and Stuart.

SUBJECT V.—MANURES.

The terms of reference with regard to Subject V were :—

(*a*) *To recommend such manures which from experience have been found economical.*

(*b*) *To recommend the best methods of conservation and application of cattle manure and the best means of extending the same.*

(*c*) *To report on Messrs. Meggitt and Birt's proposals contained in their note.*

Dr. Leather read the report.

After some discussion the Board decided that the summary prepared by the Assistant Inspector General, of the provincial notes on manures, should not be published as recommended by the majority of the Committee.

A suggestion made by the President that the notes should be published in full, with the summary, as a bulletin, was not agreed to owing to the extreme differences in the forms of the notes.

With reference to the third paragraph of the report, Mr. Sampson proposed and Mr. Burt seconded that the Board should not accept the recommendation of the Committee as regards experiments on the direct application of fresh cattle manure to land.

After some discussion as to the feasibility of this system Mr. Hutchinson, in reply to the President, said that he thought experiments with fresh as compared with rotted cattle manure might be of great value, with special reference to the biological aspect of the question.

The Board negatived the proposed amendment.

After some further discussion **the Board decided to accept the report of the Committee as printed below.**

In regard to manures, the Committee had before them the very exhaustive summary by Mr. Dobbs of the information which had been supplied by the provincial departments. The original notes from which this summary was compiled should be returned to the provincial departments for publication if and as they think fit.

Turning to reference (*b*), namely, the best methods of conservation and application of cattle manure and the best means of extending its use, the Committee find that the methods of dealing with it most effectively in the stalls vary considerably, the climatic conditions being among the chief controlling factors. In the drier parts, earth on the floor of the cattle stalls is efficient. In Berar some success has been achieved through the agency of the Agricultural Associations in popularising this practice. In other parts, such as North and South Canara, where the cultivation is very intensive and a high value is placed on the manure, the "box" system is practised by the ryots. The Committee recommend that in districts where the rainfall is small dry earth as an absorbent should be used. In districts where this is impossible owing to unfavourable climatic or soil conditions, any dry organic matter which may be available should be used. Regarding subsequent preservation of manure, the present methods employed in the villages are recognised as being apparently wasteful, but it is difficult to say what the best system should be. Local experiments to discover the best method of conservation are urgently required, and the problem should be approached from more than one point of view. The biological aspect of the problem has hitherto been neglected in India.

With regard to the best mode of application of cattle manure to the land, the Committee recommend that where conditions appear suitable local departments should experiment on the feasibility of the direct application of fresh cattle manure to the land as opposed to storing it.

In dealing with reference (*a*) which has to do with all other manurial materials, these were considered individually as classified by Mr. Dobbs.

Sheep Manure.—The Committee note that the custom of folding sheep on the land is one which is widely adopted and extremely useful.

Waste Organic Materials.—The Committee consider that it is of vital importance that everything possible should be done to encourage the application of waste organic materials to the land.

Green Manuring.—The Committee recognise that the practice of ploughing in a green crop as a fertiliser, is of very great importance and should be strongly encouraged. It is not a practice which is applicable in all cases, and it requires judgment in order to be successful. In many districts it appears to be difficult to procure the necessary seed, and in order to overcome this difficulty the Committee call attention to the Madras system of raising seed for sale instead of allowing the removal of leaves from the forests, which practice has become a serious danger to their existence in many districts. Another aid consists in the remission of water rates on land bearing a green manure crop, an arrangement which has been introduced into the Punjab and Madras, and the Committee desire to bring this to the notice of Local Governments. The Committee recommend extended study on the experimental farms to ascertain the best green manuring practices to meet local conditions.

Oil-cakes and Fish Manure.—The Committee considered these two classes of material together because they are not only highly nitrogenous organic manures, but are also similar in that they are largely exported from India. They are widely used as manures, more especially in Southern India, and the Committee consider that their more general popularisation should be one of the most important functions of the Department.

Bones.—It is recognised that finely ground bones have proved serviceable and have repaid their application in certain places, for example to paddy land in Assam, Eastern Bengal, Madras, Bengal and the Central Provinces and to coffee in Southern India. The most successful experiments have frequently been when the bone-meal has been used in conjunction with green manure. In view of the deficiency of phosphates in the soil over large parts of India, the Committee recommends the question of the economical use of bones, in conjunction with green manures, as being worthy of the serious attention of the local agricultural departments.

Saltpetre.—The Committee desire to call attention to the low cost of potash in Indian saltpetre.

Artificial Manures.—Superphosphate, Basic Slag, etc.—With the exception of superphosphate, basic slag and sulphate of potash, which are profitably used in the planting districts of Southern India for coffee and rubber, the quantity employed is negligible and the Committee feel that the question of their use in the future may suitably be left to the provincial departments who maintain tests of their value for general agricultural crops. Finally the Committee would particularly emphasise the following points :—

1. The results of experiments in the use of imported fertilisers seem to indicate that as hitherto carried out they have almost always shown a money loss. This would indicate that the methods of manurial experiment used up to the present need radical reconsideration.

2. The natural manurial resources of the country being large and varied and not having received adequate exploitation up to the present, the Committee strongly draws the attention of the various departments to studies of the value and conditions for the best use of indigenous manures.

3. Particular attention should be given to the rotation in any scheme of work designed to investigate manurial problems.

Reference (c).—The Committee are of opinion that the note by Messrs. Meggitt and Birt (Appendix C, page 66) is of sufficient importance to justify its publication in the Board's Proceedings.

15. Mr. Howard then moved **a resolution:—"That the attention of Agricultural Departments should be directed to the importance of considering, in all schemes of manurial experiments or in making recommendations for manuring, the question of the effect of manures in influencing the retention of water in the soil."**

He wished to emphasise the fact that manures have a value from the point of view of the conservation of moisture, and said that, as a result of observation, he was of opinion that their value in this respect was greater than from the point of view of plant-food.

Dr. Mann strongly supported the motion.

Mr. Birt wished to limit the scope of the resolution to organic manures, but the original resolution **was adopted by the Board.**

SUBJECT VI.—OIL-PRESSING INDUSTRY.

16. As regards Subject VI the terms of reference were :—*To make recommendations.*

Dr. Leather having read the Committee's report, a lengthy discussion took place with reference to the Committee's recommendations as to freight rates and the export of cake.

Dr. Leather explained the difficulty that the Committee had had in dealing with a problem that was mainly industrial, without reliable evidence on the industrial aspects.

The President of the Board pointed out that the inherent difficulty of transporting oil must tell in favour of the export of oil-seeds, and that the export of cake was, at present, low chiefly because cake made by indigenous methods in India was not in a suitable mechanical condition for export. He suggested that one of the first effects of extending the oil-pressing industry would be to increase the value of cake for export.

The Board decided not to accept the Committee's report.

Dr. Leather then proposed **a resolution :—"That the Board is unable to express any opinion on the subject of the oil-pressing industry except in respect of the increased use of oil-cakes."**

Mr. Stuart seconded this proposal.

Dr. Mann proposed as an amendment "that the question of how the use of oil-cakes may be popularised be referred back to the Committee," and this amendment having been rejected, the resolution **was adopted by the Board.**

FIFTH DAY.

SUBJECT XII.—THE INDIAN SUGAR INDUSTRY.

17. The Board discussed the report of the Committee appointed to deal with Subject XII.

The Committee consisted of :—

Mr. Molony (Chairman), Mr. Coventry, Dr. Barber, Messrs. Annett, Barnes, Burt, Clarke, Hamilton, Hart, Heycock, Howard, Leather, McGlashan, McKerral, Main, Meggitt, Moreland, Patil, Plymen, Robertson-Brown, Sampson and Taylor.

The terms of reference were :—

(1) *How can the present practices be improved, and in what particulars, under the following heads :—*

(a) *Mechanical.*

(b) *Agricultural.*

(c) *Botanical.*

(d) *Marketing, intelligence and distribution for :—*

(1) Gur *or* jaggery.

(2) *White sugar ?*

Is the production of gur *or* jaggery *for consumption as* gur *or* jaggery *a different problem to its production as a basis of white sugar ? If so, in what do these differences consist and what should be the treatment in production for each object ?*

(2) *In what ways and under what conditions can the production of white sugar be economically brought about (a) as white sugar direct from the cane, (b) as refined sugar from* gur *or* jaggery, *(c) as refined sugar from other forms of raw sugar ?*

(3) *In what tracts is there scope for the increase of area under cane ? What would the area amount to that could be economically brought under cane ? Whether any assistance is required and of what kind or shape ? Whether any obstructions exist to enterprise either in the shape of land tenure systems or other hostile conditions, and, if so, what recommendations can be put forward for their removal ?*

The following is the report of the Committee :—

Dual aspect of problem.

(1) *Reference I.*—The Committee considers that the problem presented is a dual one, namely, the production of *gur* for eating and also the production of refined sugar either direct from the cane or from *gur*.

Relative importance of each branch.

(2) As to the relative importance of these two aspects, at present the production of *gur* for eating is the most important, but there is a general tendency in the direction of the increased consumption of refined sugar. It is, however, impossible to predict, for India as a whole, to what extent the relative importance is likely to vary in the near future.

The position requires careful watching.

The *refined sugar industry is more immediately threatened by the competition of imported sugars.*

(3) It is the opinion of the Committee on the evidence before it that the problems of the production *of gur for eating and of refined sugar, are not necessarily different so far as variety of cane* is concerned, as high quality canes can serve both purposes. However, the suitability of high yielding canes of lower purity, which, though unsuitable for refining, might prove suitable for tracts producing *gur* for eating only, might be investigated for the benefit of such tracts.

Mechanical aspect.

(4) As to sub-section (*a*) of the first reference the Committee is of opinion that there is very great scope for improvement both in bullock-driven cane mills and also in boiling plant.

The provincial departments should co-operate in the investigation and introduction of improved methods.

The Committee endorses also the recommendation made in the note of the Officiating Inspector General of Agriculture (Appendix E, page 79) that an expert Sugar Engineer should be appointed to undertake the work assigned to him in the note.

Agricultural aspect.

(5) The Committee then considered the subject of cane cultivation from the agricultural and chemical aspects. It endorsed the recommendation in the Inspector General's note that the provincial departments should co-operate—

(*a*) in the survey and testing of local varieties under chemical control: this should be carried out at agricultural stations situated in cane-growing tracts ;

(*b*) in testing such imported varieties as appear *primâ facie* suitable ;

and that the provincial departments should—

(*c*) facilitate the distribution of the best varieties so determined ;

(*d*) demonstrate improved mechanical methods ; and

(*e*) study questions of tillage, watering, manuring and drainage in the light of local conditions so as to increase the weight of cane per unit of area.

It recognises that action on these lines will require considerable staff and expenditure and that the rate at which action can proceed depends upon the resources of the provincial departments.

Botanical aspect.

(6) The proposals embodied in Mr. Howard's note on cane-breeding in Madras (Appendix E, page 80) were discussed. In view of the fact that the work proposed to be there done would be almost entirely for the benefit of other provinces, it was considered desirable that the station proposed should be Imperial and not Provincial.

It was proposed by Mr. Howard and seconded by Dr. Barber that an acclimatisation and cane-breeding station be established under an Imperial officer in Madras, and that this officer should be in close touch with sugarcane development in Northern India. This was accepted unanimously.

Marketing, Intelligence and Distribution.

(7) The Committee agreed with Mr. Shakespear's remark (Appendix E, page 81) that excellent organisation already exists for the marketing of both country-made raw and refined sugars, and do not consider any recommendation necessary.

(a) *The Production of refined sugar direct from cane.*

(8) *Reference 2.*—Mr. Moreland pointed out that the United Provinces had obtained considerable experience in the improvement of the indigenous method, and, by the introduction of the centrifugal, had helped to maintain the indigenous industry in certain areas, but that more information was wanted.

Some preliminary results had been obtained from a small modern factory at the Allahabad Exhibition. This factory had now been set up in a sugar-growing tract in Gorakhpore and it was expected that further valuable data would soon be obtainable.

In the opinion of the Committee, the data before it are not sufficient to justify any statement as to the form of organisation of the industry most suited to India as a whole or to any particular cane tract. It recommends that facilities be freely given for the trial of as many *different forms of organisation as possible.*

The most fundamental and important work is the production of better canes with pure juice which defecates easily. The Committee also recognises the importance of an investigation of the constituents of Indian canes other than sugar. It was pointed out that machinery unsuitable to Indian conditions had sometimes been installed in India owing to lack of expert advice and that the Sugar Engineer whose appointment had been proposed might do useful work in this direction.

(b) *The production of refined sugar from* GUR.

(9) The Committee is of opinion that no separate recommendation was necessary on this point, as factories designed for working cane can easily be adapted to work *gur.* Here again the improvement of the cane is of fundamental importance.

(c) *The production of refined sugar from other sources.*

(10) *The Committee is of opinion that investigation is required into the chemical and agricul*tural aspects of the palm sugar industry.

More precise information is also required on the extent of the industry.

Assistance required.

(11) *Reference 3*—With reference to the economic production of refined sugar the Committee wishes to draw attention to its recommendations under the third reference under the head of "assistance" which should be given by way of subsidy or otherwise.

Areas for extension.

(12) *United Provinces.*—Mr. Moreland pointed out that the normal area under cane in the United Provinces could be taken as 1·2 million acres, that it had gone as high as 1·5 million acres and was now in round figures 1 million acres; that after a succession of good years the cane area increases by as much as a quarter of a million acres, and that after bad seasons it falls by as much as half a million acres. *He considered that the area under cane* was governed chiefly by probable prices, and by the economic position of the cultivating classes for the time being. He further pointed out that, although it was difficult entirely to separate *gur* and sugar production, it was in the districts producing refined sugar that the area of cultivation had fallen off. As an instance he quoted the Meerut Division, whose total exports and imports of refined sugar were practically equal, but which was a large exporter of *gur,* as having shown a considerable increase in cane area since 1890, whereas in Rohilkhand, which exports some *gur* but much more refined sugar, the normal cane area had not been reached since 1898. With reference to possible extensions in area under cane, he pointed out that, in addition to the half million acres now short of the recent maximum, a further 300 000 acres out of the 400,000 acres of poppy land might be considered available for cane-growing, or a total of 800,000 acres, provided cane-growing could be made somewhat more remunerative.

Calculating on a somewhat different basis, namely, the proportion of cane cultivation to the total cultivated area, he estimated that an increase of 1,000,000 acres was possible in a period of five years, without seriously affecting existing agricultural economics.

Bengal.—Mr. Heycock said that there was a considerable additional area which was capable *of being put under sugarcane cultivation, but that there were not sufficient* data to enable him to say how much of this area it was possible to bring under cultivation.

Madras.—Mr. Sampson described in detail the various tracts in which a considerable extension of cane cultivation would be possible, provided that water was found, as a result of the survey of the sub-artesian water sources, which has now been commenced. The districts referred to were—Vizagapatam, Trichinopoly, South Arcot, Chingleput, and the tract near the hills between Tinnevelly and Coimbatore. The West Coast had an admirable climate for cane cultivation, but was a narrow strip of country, cut up into small valleys, probably unsuitable for factory cultivation.

As an example, to show that a large extension of cane cultivation is possible by the introduction of better varieties and methods, he quoted the case of the East India distilleries and sugar factories, at Nellikuppam, which has caused in the last three or four years an increase in cane area from a few hundred to 2,500 acres for the use of the factory in making white sugar direct from the cane. This was done (1) by demonstrating the feasibility of growing canes on land hitherto considered by cultivators as unsuitable for cane cultivation, *viz.*, dry land commanded by wells with a copious water supply, (2) by the introduction of the red Mauritius cane, (3) by improved methods of cultivation and by assistance in the supply of manure, sets for planting, etc.

Bombay.—Mr. Main pointed out that, in Bombay, cane was essentially a canal irrigated crop, and that there was little probability of extension under well irrigation. He thought that when some of the large irrigation schemes in the Deccan are completed, the present area of 34,000 acres might be doubled in 10 years, and that the area under cane was governed by the supply of water and capital, the latter of which difficulties, it was hoped, would be met by the establishment of the Bombay Land Bank, which purposed to lend money to Co-operative Credit Societies.

Eastern Bengal and Assam.—Mr. Meggitt stated that in the Assam Valley there was apparently an almost unlimited amount of culturable jungle land, suitable only for capitalists' exploitation owing to the cost of reclamation. It had been shown by actual experience that this land could produce a good outturn of cane with pure juice, climatological and soil conditions being quite suitable, and irrigation unnecessary.

The labour supply would probably be a limiting factor.

Mr. Hart stated that there was a want of precise statistics on the point, but that in Eastern Bengal cane had largely been replaced by jute. So far as suitability of soil is concerned there is scope for an enormous expansion of sugarcane cultivation, not only in the Assam Valley but also in many tracts of waste land in Eastern Bengal. Unless, however, the industry becomes more profitable, sugarcane cultivation will continue to decrease.

Central Provinces.—Mr. Plymen said that cane cultivation under well irrigation had largely disappeared, and any extension of cultivation could only be expected on land commanded by tank irrigation. It was hoped that a considerable proportion of the 700,000 or 800,000 acres of land likely to be commanded by new irrigation works would be put under cane. The Local Administration, with a view to encouraging the establishment of a central factory, had agreed to the reservation of 3,000 acres of suitable waste land surrounded by villages, where small quantities of cane are already cultivated ; the whole protected by a large irrigation work and conveniently accessible.

Punjab.—Mr. Hamilton said that there was no real hope of extension owing to the periodic damage by frost, except possibly in the area commanded by the Lower Bari Doab Canal where suitable facilities might be given to capitalists if they desired to come forward.

Burma.—Mr. McKerral stated that in Lower Burma there were 19 million acres of culturable waste land, a considerable proportion of which might grow sugarcane as the climate appeared to be suitable.

Mysore.—Dr. Coleman said that the present area under cane, approximately 50,000 acres, might not improbably be doubled during the next 10 or 15 years if the energetic irrigation policy of the Mysore Government is maintained.

Scarcity of labour would, however, create some difficulty.

(13) After considering the facts above detailed, the Committee finds that there can be no doubt that there is a large area in each province capable of being brought under sugarcane cultivation ; but whether there is a possibility of extending the area and attracting capital depends entirely on whether, having regard to the local conditions in each province, it can be shown that it is a profitable investment to grow cane.

Kind of assistance required.—Land acquisition.

(14) It was agreed that prospective central factories required assistance in acquiring land for a definite compact area of cane cultivation.

Mr. Moreland proposed that the Government of India should be moved to consider the question of passing a temporary Act enabling Local Governments to acquire land, free of owners' and occupiers' rights, for transfer to pioneer central factories. This resolution was put to the vote and lost by a majority.

(15) *Pecuniary assistance*.—Mr. Heycock proposed and Mr. Moreland seconded a resolution that it should be open to Local Governments to assist pioneer factories either by subsidy, by taking deferred shares, or otherwise. This resolution was carried unanimously.

(16) *Land Grants*.—It was also agreed that all Local Governments should be recommended to consider favourably where possible, the grant of lands on special terms for sugar cultivation.

Work already in progress to assist cane-growing.

(17) In section II A of his note the Inspector General advocated the following remedies for removing the defects in present Indian agricultural practices—

(*a*) To survey and test local varieties under chemical control.

(*b*) To test such imported varieties as appear *primâ facie* suitable,

(c) To facilitate the distribution of the best varieties so determined.

(d) To demonstrate improved mechanical methods.

(e) To study questions of tillage, watering, manuring, and draining in the light of local conditions so as to increase the weight of cane per unit area.

With reference to these recommendations the following work is in progress, in the various provinces :—

United Provinces.—(a) A survey of canes of the eastern tracts at Partabgarh station and their chemical examination. A new station is to be opened in Rohilkhand to do similar work for the western cane growing tracts.

(b) and (c) A small amount of work has already been done which will be continued as opportunity offers.

(d) This forms part of the ordinary work of every circle.

(e) In progress.

Punjab.—(a) and (e) The recently opened station at Gurdaspur is in a sugarcane tract where the survey has commenced, and it is intended to start chemical examination.

(b) to (d) Not yet commenced.

Central Provinces.—There are two newly opened stations in tracts recently brought under irrigation where sugarcane cultivation is being introduced. A certain amount of survey and chemical testing has been done at Raipur, where—

(b) imported canes have also been tried ;

(c), (d) and (e) operations are in progress.

Burma.—No funds are available for cane investigation at present, but it might be possible to start a survey.

Bombay.—(a) The agricultural survey of canes is complete and the testing of imported varieties has been almost discontinued. A new station has been opened, in the southern part of the Deccan, for testing the suitability of varieties to local conditions in that tract, and also for experiments on tillage, manuring and watering.

Tillage and manuring experiments are also being continued at Manjri and cuttings of a disease-free cane are being distributed in Gujarat.

The advantages of the Poona type of furnace for *gur* making and of efficient bullock mills and small power mills are being demonstrated.

Madras.—(a) and (b) The cane survey is practically complete and the testing of the best varieties, both indigenous and imported, for suitability to particular tracts is being carried on at four stations. A new station is being opened at Anakapalle also in a cane district.

The importation and testing of foreign varieties continue.

(c), (d) and (e) Iron mills have already been introduced in all districts except South Canara, and efforts are being made to introduce them there, as well as better boiling pans.

The introduction of small power mills has been taken up.

Bengal.—(a) The agricultural and botanical survey and chemical testing are in progress at Sabour. There is no special sugar station.

(b) Some importation, and testing of canes imported from Java and other places.

(c) Distribution of above varieties.

(d) Attention is being paid to the introduction of iron mills.

(e) Experiments are in progress on tillage and manuring.

The Committee records its opinion that it is essential that Bengal should have a sugar station in a sugar tract north of the Ganges.

Eastern Bengal and Assam.—(a) and (b) Survey and testing are in progress at Jorhat and are being commenced at Dacca.

(c) Work has been in progress for some years and will continue on a large scale.

(d) Improved bullock mills and boiling pans are being demonstrated.

(e) Work is in progress.

North-West Frontier Province.—(b) Trials of imported varieties.

(e) Trials in methods of cultivation with the object of reducing the cost of production.

Mysore.—(a) The four varieties chiefly grown have been tested chemically. Three of these were found to be exceedingly good canes.

(d) Iron mills have been introduced in all but the most backward districts. Steps are now being taken to introduce Nahan bullock mills which have proved superior. Four or five three-roller horizontal mills, driven by oil engines, have been set up with very satisfactory results.

It may be noted that there is one refinery, situated in a fine cane growing tract, which nevertheless has had to confine operations to refining from palm jaggery imported from the Madras Presidency, owing to the impossibility of getting guarantees from the cultivators of sufficient cane at a fixed price.

18. The report having been read by Mr. Molony, the President opened the discussion, and, in view of the wideness of the field and the importance of the subject, proposed that a series of resolutions, drafted for the purpose of focussing the discussion, should be proposed and seconded by members of the Board. Amendments should be handed in writing. He then called on Mr. Moreland, who

moved:—"**That the Board cordially endorses the position taken by the Inspector General of Agriculture in India, in his note to the Government of India,* that the sugar industry deserves the assistance of Government.**" Res

Avoiding controversial points and confining himself to Northern India, to which his experience of the industry was limited, Mr. Moreland explained the present economic position, with a sketch of the manner in which the industry grew up.

Cultivators had, for a long time, made *gur* for local consumption. Trade in sugar originally arose owing to the demand of the Court. A market being thus created, the East India Company in the seventeenth century used to send to Agra, the capital, for sugar. In the nineteenth century, with the extension of order and communications, trade increased, firstly, owing to organisation of markets, secondly, through localisation of cultivation; for example, in the United Provinces, sugarcane was localised in the North and East, cotton in the South and West. There was no foreign competition. The present state of the industry was thus determined. The growers were not capitalists or specialists, but the best cultivators grew plots of cane, co-operating where necessary rather than paying cash wages. We therefore find the defects common to agriculture—cultivation good within the limits of implements and cattle power; but varieties of cane varying greatly in quality, and methods crude and wasteful. The most important feature, in the United Provinces, is that the industry employs labour when there is little other work, acting as the great labour's savings bank of a country of small holdings, and adding largely to the spending power of the people. Encouragement of the industry was justified by this alone.

At the end of the century competition due to sugar bounties was checked by countervailing duties and the Brussels Convention, but followed by competition from Java. *Gur* was threatened by importations and change of taste in favour of sugar, and sugar already affected by competition of imports. Roughly, the area grown for *gur* was not yet materially affected, but that grown for sugar was. [This Mr. Moreland illustrated by a diagram showing a general increase since 1901 in the cane area of the *gur* exporting district of Meerut, and a decrease in that of the sugar-producing district of Rohilkhand, on the other side of the Ganges.] Continuing, he said that only Hindu prejudices enabled local sugar to compete, and these prejudices were, he thought, already weakening and would not last. The interval due to this protection of sentiment should be used to reduce progressively the cost of production, and he urged the importance, in the interests of agriculture, of both helping to regain ground and of extending the industry on this the only sound basis.

Mr. Barnes seconded **the resolution,** which **was unanimously adopted by the Board.**

19. The President then read a letter from Mr. Neilson, Manager of the Factory at Nellikuppam, which was appended to the other notes on the subject before the Board. (Appendix E, page 83.)

20. Mr. Burt, at the President's request, then proposed the next resolution. "**That the Board accepts the recommendation of the Committee regarding the employment of a Sugar Engineer.**" Res

He referred to the mention of mechanical improvements in the Inspector General's note and emphasised the importance of heat economy owing to the extent of recovery of sugar being limited by the amount of re-crushing possible with the megass as the only fuel, economically speaking, available: the difficulty would be increased with the introduction of more juicy cane. Investigations on this would require the assistance of an Engineer.

Much unsuitable machinery had been installed in the United Provinces owing to the absence of expert advice. In the peculiar economic conditions of India, neither tinkering of present methods nor radical alteration in the direction of large factories seemed likely to be satisfactory. The most efficient form and size of plant and the cost of production were still to be worked out.

Experience with the factory at Allahabad had shown the need for mechanical improvements. He did not wish to suggest a programme for an Engineer, but to indicate the general need for mechanical assistance.

* Appendix E, page 79.

Mr. Sampson, in seconding the resolution, said the wastefulness of present methods must limit the area under cane; and pointed out the probable value of an Engineer in assisting the installation of economical machinery by co-operative societies.

The Board unanimously passed the resolution.

21. The President then read out the third draft resolution.

"The Board accepts the recommendations of the Committee regarding the programme of agricultural work. It lays special stress on the importance of locating sugar stations in sugar tracts, and only in such tracts: and desires to suggest for the consideration of the Government of Bengal that the establishment of a sugar station to the north of the Ganges is most desirable in the interests of the industry."

He called on Dr. Mann, who pointed out the importance of the factor of yield per unit area and its bearing on the question of local stations. In Poona with a yield of 80,000 lbs. of cane per acre the profit was normally R200, while in districts where the yield was 20,000 to 25,000 lbs. the industry was dying. He thought only intensive cultivation could pay; the proportion of profit increased with the capital laid out which at Poona reached R450 per acre. Cultivators would rightly not incur such outlay without more definite information than was available. Attempts to apply Poona methods at Cawnpore had failed, and it was necessary first to find out the methods of obtaining high yields in sugarcane districts and then to advocate them.

The area of cane could not be increased without getting the best canes and cultivating them highly; better cultivation could not be spread before decreasing the risk of loss of capital; and the risk could not be decreased without further information. Sugarcane stations were therefore necessary in such districts. Instancing the success of the Manjri Farm, he moved the resolution.

Mr. Clouston, in seconding the resolution, said experiments were being made at Raipur and in Chanda, in the Central Provinces, and referred to the steps taken by the Central Provinces Administration to provide irrigation from Government tanks, 3,000 acres so irrigated having been reserved for any company that might come forward.

In reply to a question by the President, Mr. Clouston explained that irrigation all the year round is essential for the growth of sugarcane, and that, this being ensured, there was no danger of the loss of the capital invested in its cultivation or of consequent famine.

The Board adopted the resolution.

22. At the President's suggestion Mr. Howard moved the resolution that—**"The Board accepts the recommendation of the Committee regarding the establishment of an acclimatization and cane-breeding station in Madras."**

He referred to his printed note (Appendix E, page 80) and said he had no wish to say anything further.

Dr. Barber seconded Mr. Howard's motion. He drew attention to the fact that those who had visited the chief sugarcane-growing countries of the world, were filled with astonishment when first seeing cane fields in Northern India, and, to such, the problem which first presented itself was, rather, how to increase the weight of canes per acre than any improvement in manufacture. The fundamental problem in the resuscitation of the Indian sugar industry he regarded as the increase in tonnage coupled with the growth of canes of greater purity.

There appeared to him to be a curious antagonism between good agriculture and good manufacture in the cane industry. Java undoubtedly owed her proud position as the premier sugar-growing country to the fact that a band of scientific men had attacked every part of the complicated problem, from the selection and growth of disease-resistant seed to the best processes in the factory. In Louisiana the manufacture was of very high grade, while the cultivation, if not in itself bad, had many difficulties to contend with. Barbados was still very backward in the factory, whereas the cultivation in the fields was, perhaps, the best in the world. India, finally, appeared to concentrate the greatest agricultural and manufactural defects in the cane industry of the world. The main lines of improving cane growing were—the improvement of the cultivation and the introduction of a better

class of canes. The latter alone was considered by Dr. Barber, and, of the various methods of obtaining improved canes, the following were considered :—

(1) *Sports.*—These consisted of new canes, rising spontaneously in the fields. There was no means known at present of inducing sporting among canes. Sports, or mutations, were a free gift of nature to man. As an example Dr. Barber quoted the case of the Caledonian Queen which, casually noticed by a planter in his field in St. Kitts and kept as a curiosity, practically saved the industry in the island from destruction through disease in 1893.

(2) *Selection, including the acclimatization of exotic canes.*—The work at the Samalkota Farm was referred to, and it was pointed out that the collection and testing of a large number of canes had resulted in the almost total replacement of the old, diseased kinds in the delta by new and better ones. In the same way the great extension of the well irrigated cane area in South Arcot was largely dependent upon the presence at hand of a thoroughly reliable Samalkota cane. Dr. Barber pointed out that the work was by no means so easy as it appeared. The 40 or 50 canes collected on the Samalkota Farm were tested for several years in every possible way before being distributed, and the fact became evident that canes of great excellence in one tract were useless in others. The excellent Pounda cane of Bombay became hopelessly diseased at Samalkota. The tillering of the red Mauritius cane was very poor in the Godavari delta, whereas in South Arcot a bunch of 30 canes had been noted springing from one set.

(3) *Cross-breeding.*—The creation of new varieties of canes is a matter of delicate scientific technique, and there is reason to suppose that it will be specially difficult in India, because of the dryness of the air. Dr. Barber quoted cases, kindly given him by Mr. Somers Taylor, of successful results obtained by the introduction of seedling canes in the West Indian Islands and Louisiana, and pointed out that Java's supremacy was traceable, to some extent, to the energetic way in which this line of work had been carried out there. In Madras several of the West Indian and Java seedling canes had proved of service, especially B 208, which was a cane of great purity, moderately stout in growth, and of good tillering power.

These lines of work should be held in view in any cane-breeding station, and Dr. Barber considered that the conditions in the Madras Presidency were better suited than those of any other part of India. Cross-breeding was not likely to be possible elsewhere; considerable experience had already been gained in Madras in this class of work, and the actual growth of the canes was much easier there than in North India. But the officer in charge should be in close touch with the large cane-growing areas of North India, and there should be a constant drafting of canes, from the cane-breeding stations, to experimental stations in the north. In sending canes for trial, however, it was of great importance to remember that a cane unsuitable for Madras might prove of value in Northern India, and *vice versâ*. No cane should be prematurely rejected. As Mr. Taylor had pointed out, the canes which were being so successfully cultivated in Louisiana, D 74 and D 95, were seedling canes from Demerara which had been rejected as unfit for growth there.

Dr. Butler doubted whether the suitability of Madras had been sufficiently considered, having regard to the very different conditions of Northern India, and the variability of cane referred to by Dr. Barber. He proposed, as an amendment, that the Committee's recommendation be accepted with the omission of the words "in Madras."

Mr. Howard said that the point had been discussed in Committee. United Provinces canes could be sent to Madras for breeding purposes. A breeding station was of no use in Upper India, where seed production was practically impossible. Acclimatization was of less importance. A most important point was that the man chosen for the work should select the station.

Dr. Butler suggested that, as regards acclimatization, it would be better to import canes from Japan, Louisiana, Natal and other places with a marked cold season, direct into Northern India.

Dr. Barber explained that the United Provinces were already starting two stations and the Committee advocated Madras as merely one feeder for these farms.

The amendment was withdrawn.

The President then put **the resolution,** which **was passed unanimously.**

23. Dr. Leather then moved—"**That the Board recognises that the most important work is the production of better canes with pure juice, and accepts the view of the Committee as to the desirability of an investigation of the constituents (other than sugar) of the Indian canes. It also accepts the Committee's view that investigation of the palm sugar industry is desirable from the chemical and agricultural points of view.**"

After a reference to other important qualities of canes, Dr. Leather dealt specially with the two points, proportion and quality of juice. As regards proportion, he explained that the percentage of fibre varied from 8 to 16 or 18: fibre, acting like a sponge, retained about 2½ times its own weight of juice, after crushing, with a resulting difference between 72% and 50% of juice yielded by different canes.

As regards purity of juice, he had met with canes varying from a content of 10% of sucrose combined with 2% of glucose in addition to mineral salts, up to a content of 22% of sucrose with only a fraction of a per cent. of glucose. Even these figures did not fully illustrate the divergence which might occur, because the impurities not only form a part of the whole, but also prevent a part of the sucrose from crystallising. Thus in the former case, not much more than one-half of the sucrose could have been obtained as white sugar, whilst in the latter something like nine-tenths would be separable in a factory.

The quality of canes in India was not low, but variation demonstrated possibilities of improvement. For example, a general improvement in quality to the extent of 25% would mean an increase of 250,000 tons in the sugar outturn of the United Provinces. He placed a high value on Mr. Clarke's work at Partabgarh and Mr. Taylor's in Bengal. With reference to palm sugar, he said that the industry, though not small, might be extinguished owing to the ease of making the juice into spirit. The processes of manufacture were different from those in the case of cane sugar, and deserved very careful investigation.

Mr. Clarke, in seconding the resolution, said that impurities of raw material were responsible for more difficulties than methods of boiling, and laid great stress on the value of the quality of purity. He doubted the possibility of obtaining very high yields in Upper India: 22 to 25 tons of cane per acre, containing 15% of sugar, of a purity of 85, had been obtained at Partabgarh and Aligarh, and he doubted if much more were obtainable there in practice. Knowledge of constituents of cane juice other than sugar was required, and could be obtained only by highly technical investigations.

Mr. Annett said that 480,000 out of 3,000,000 tons, or 16% of India's production of sugar, was palm sugar. The industry was wide-spread, and the products largely consumed locally. Practically no scientific work had been done hitherto. The yield per acre had sometimes been estimated at 9 tons. The methods of boiling were very defective. Sugar was obtained from date, palmyra, cocoanut and Indian sago palms, and the occurrence of the date and palmyra seasons in the cold and hot weather, respectively, makes a long season possible. The industry was capable of great improvement.

The resolution was carried unanimously.

24. Mr. Molony moved the next resolution.

"**The Board considers that the area under sugarcane in India can be considerably increased by the application of capital and the introduction of more efficient methods of cultivation and manufacture. It accepts the recommendation of the Committee that all possible facilities should be afforded to capitalists, whether small or large, who are prepared to undertake the industry.**"

He drew attention to the surprising figures of the area available for sugarcane cultivation, especially in the note from Eastern Bengal and Assam.

He classified the land available as—

(*a*) on the margin of cultivation, and

(*b*) undeveloped land,

and showed that the profitable use of (*a*) would depend on reducing cost of production by intensive cultivation, involving the application of capital, and by using modern and less wasteful methods of manufacture, involving capital expenditure on plant. As regards (*b*) the hindrances were, want of water, cost of clearing and lack of labour. Water was receiving the attention of Local Governments, but capital was required for clearing and to attract labour. An instance of capital increasing the area of sugarcane was at Nellikuppam where the area increased from a few hundred to 2,500 acres owing to the establishment of the factory. The facilities to be given could not be specified, but some means of advancing the large sums suggested by Dr. Mann as necessary for intensive cultivation would have to be found.

Mr. Meggitt seconded the resolution. There seemed to him no half-way-house between the present conditions and large central factories; the percentage of sugar recovered varied, with the methods used, from 50 to 55% in India to 90% in large factories in Java. Loss and waste could also be enormously reduced.

He thought it was not enough to distribute a good cane, but that assistance, supervision and capital were necessary, and that the Agricultural Department should be prepared to give data for the formation of an opinion by capitalists as to the likelihood of profits in different tracts. In this respect the recommendation did not go far enough.

From experiments in the Assam Valley it could be said that it was possible to grow 30 tons per acre of cane, containing 17 to 18% of sugar, and with a purity of 90. Definite data of this nature would go a long way towards attracting capital.

Mr. Molony proposed to add to the resolution the words—"**In particular that all Provincial Departments should endeavour to supply the detailed information that capitalists would be likely to require,**" and **the resolution, with this addition, was carried unanimously.**

25. In moving the seventh resolution on this subject—"**The Board recognises the value of the action already taken by some Local Governments to reserve certain areas of suitable land for the establishment of central factories, and hopes that similar action may be taken, where possible, by other Local Governments, and that grants of available land may be made on favourable terms**"

—Mr. Hamilton said that in France more stringent measures were taken to favour central factories. No expropriation was desirable, but blocks of irrigated land, where available, should be devoted to this purpose. Land available in the United Provinces and the Punjab was probably in areas unsuited to cane-growing.

Mr. McGlashan, in seconding the resolution, said that until sugar could be produced in India at the minimum price of the imported article, the industry was not on a sound basis. A factory dependent on purchased cane would be in an insecure position owing to fluctuation of prices and competition. If factories obtained tracts of land and grew their own cane, they would set a standard of cane cultivation, attract supplies of cane, advance money for cultivation, and would assist the Agricultural Department by demonstrating methods and supplying information. In suitable conditions a sugar factory, being independent of other industries, would be relatively easy to establish.

The resolution was put to the Board and **carried unanimously.**

26. Mr. Heycock then moved that—"**The Board recommends that Local Governments should be empowered to assist pioneer factories, by subsidy, by taking deferred shares, or by such other methods as may be appropriate.**"

He reviewed the facts and arguments that showed assistance to be necessary to promote the industry, and said a pioneer industry should be subsidised during the first few years until it had obtained a sufficiently steady supply of cane to enable an opinion as to the ultimate profit or loss to be formed.

Mr. Plymen seconded the resolution, and explained that, in areas like the Central Provinces, extension of cultivation meant export, as population was scanty. It was difficult to attract capital. Government was already financing growers of cane with a view to increasing the value of irrigation water, and might find it possible to assist manufacturers.

The President supplemented Mr. Heycock's remarks as to the necessity of a subsidy in India. In other countries it was not difficult to get possession of land by lease or purchase ; here the *zamindari* and *ryoti* system of dual ownership caused a difficulty in getting sole rights. Therefore, to avoid heavy outlay for acquisition, combination between the two parties was necessary, and this doubled the risk as compared with cases where single control could be obtained and results rapidly judged. Some help to pioneer factories was thus almost necessary in India.

27. Mr. Moreland proposed as an amendment the addition of the following words :—

" And urges the need for a reconsideration of the recent orders of the Secretary of State, in so far as they prevent the application of public funds to the development of those industries which are essential to the increase of the wealth of the agricultural community."

He explained that the wording of the resolution was opposed to certain orders recently issued by the Secretary of State limiting the power of Local Governments to give effect to the resolution—they would make effective action practically impossible. He suggested making it plain that the Board was asking the Secretary of State to reconsider the orders. He was not dealing with general industrial development dependent on minerals, forest produce, etc., but with such as was dependent on agricultural produce.

A very important branch of agricultural industry was threatened owing to unsatisfactory conditions ; facilities were required, not for new developments, but for agricultural improvement. He instanced the case of oil-pressing, and the importance of keeping oil-cakes in the country. After 12 years' discussion and discouragement, an oil mill for crushing cotton seed was set up in the United Provinces by the Local Government, capital being shy. There was no difficulty in making or selling oil. A demand was just springing up for the cake, when, in consequence of the orders referred to, the factory had to be shut down. There were here two instances of potential resources awaiting development, and the object of the amendment was to obtain a free hand to secure, not general industrial expansion, but that of such industries as are essential to the development of agriculture.

The amendment was *put to the Board and* **carried.**

The resolution as amended was passed unanimously.

SIXTH DAY.

28. The President invited the Board to consider whether the subject " The Indian Sugar Industry," being of major importance, should be entered as a permanent item on the Board's programme. He thought this course would centre the department's attention on the subject and encourage progress, the periodical reporting and, if necessary, publication of which would meet Mr. Meggitt's suggestion as to supplying information. Dr. Leather thought that bringing it up specifically at the next meeting would be better. Mr. Meggitt agreed with the President and suggested, in addition, that the chief references should be circulated at least six months before the meeting to enable points to be worked up. Mr. Sampson thought the subject too large to tackle at one meeting, and suggested taking sections selected by the President.

Dr. Leather proposed :—**" That the subject of the Indian sugar industry be considered again at the next meeting of the Board."**

He would like to know a week or so before the meeting, what had been done as regards particular points, *e.g.*, the Board's recommendations as regards a Sugar Engineer, sugar factories, and the proposed Madras station ; and would suggest that those who were carrying out specific work should be asked to send in papers a month in advance.

Mr. Burt seconded **the resolution,** which **was carried unanimously after** *some discussion.*

The President undertook to see that effect was given to the recommendations contained in paragraphs 69 to 71, page 16 of the Proceedings of the Board, 1906.

29. The Reports of the Committee on Subjects IV and IX were then discussed.

The Committee consisted of Dr. Mann (Chairman), Messrs. Clouston, Evans, Hart, Lonsdale, Main, Milligan, Powar, Sherrard, Smith and Stuart.

SUBJECT IV.—BEST MEANS OF BRINGING THE RESULTS OF EXPERIMENTAL WORK TO THE NOTICE OF CULTIVATORS.

The terms of reference as regards Subject IV were :—

To amplify as far as possible the reports already published.

In opening the discussion on this subject, Dr. Mann emphasised, particularly, the passages in the report which related to the growing connection of the Agricultural Department with the co-operative movement, the increased use made of the department, as regards assistance in marketing of new products, and the new developments in methods of training the sons of cultivators. He also laid stress on the two points urged in the conclusion of the report—concentration, and co-relation between experimental and field work ; and said the provision of an ample staff was to be recommended.

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Mr. Howard proposed a resolution :—"**That the Board is of opinion that the time has come for considering the question whether the Agricultural Department should not work in closer touch with the co-operative credit movement, as the object of both is identical, *viz.*, the improvement of the rural economy of the country.**"

It seemed to him the time might come when the Agricultural Department would have to take over the organisation of co-operative credit.

Mr. Sampson seconded the resolution. Mr. Heycock advocated sympathy between the two departments but said that in Bengal it had now been decided to separate them finally. Mr. Evans said this was also the case in the Central Provinces, but gave instances showing that the two departments were tending to work more and more closely together.

Mr. Moreland deprecated combination of the administration of the two departments, owing to the official association of agriculture with matters extraneous to the co-operative movement, *e.g.*, industries and veterinary administration, in some provinces. This need not prevent their working together. Six years ago work in common had been decided on in the United Provinces, but only this year was it beginning in six districts which were ready for it.

Mr. Molony said this was an example of the method pursued in the United Provinces of :—

(1) education in co-operation,

(2) work in common with the Agricultural Department when the time came.

The Board adopted the resolution.

30. The President drew Dr. Mann's attention to a slight inaccuracy in the wording of the report as regards "Nature study" which, as Dr. Mann explained, was used as a method and not taught as a subject in the school referred to ; the passage was amended. In further discussion of the school the President and Dr. Mann explained to Mr. Molony, who doubted if the Agricultural Department would be allowed to set up an independent system of education, that the Director of Education in Bombay agreed and co-operated with the Agricultural Lepartment as regards the school. The school was expensive—R5,000 a year for 50 boys. The President suggested that expansion would imply a large increase in the organisation of the Agricultural Department, and Dr. Mann advocated gradual growth from small beginnings.

31. With regard to the storing of potatoes in sand mentioned in the report of the Committee, Mr. Woodhouse said the essential feature was the appointment of a cultivator as *choukidar* in the first year, and the allowance to him of a commission on the amount of seed stored by other cultivators in the second year. In the first year 196 and in the second 8,500 maunds were thus stored. In reply

to a question by Mr. Howard he said the commission bore no appreciable proportion to the profits made by protecting the potatoes from the moth.

32. After some further discussion **the Board decided to accept the report of the Committee, as amended below :—**

SUBJECT IV.

At three former meetings of the Board of Agriculture (1908, 1909, 1910) a Committee has considered the subject which has been referred to the present Committee, and as a result of their deliberations two reports have been issued, which were largely a collection of instances of success in bringing improvements to the notice and into the practice of cultivators. The present report must be considered as a supplement to these two, and is an attempt to collect a few of the more prominent advances which have been made during the last two years, and the methods which have been successful in those cases.

Agricultural Associations.—The development of the utility of agricultural associations has gone on apace in some parts of India, notably the Central Provinces; in others they have shown such lack of life, vigour and utility that it has been recommended to dissolve them, at least in the form which they have had up to the present. The whole matter of agricultural associations is, however, being dealt with in a separate report, and nothing, therefore, will be said here on this subject.

Local Demonstrations.—Considerable developments as to methods and results have taken place in this direction.

In the Central Provinces large numbers of demonstration areas are now worked, belonging in all cases to private owners who allow them to be used for the purpose. In connection with these the *Kamdar* scheme outlined in the last report has proved of very great value, and the men engaged as *Kamdars* now pass from demonstration of one thing to another during different parts of the year. Thus a large number are now employed, after training, to demonstrate the transplanting of paddy, to show the proper method of irrigating wheat, to plant sugarcane according to the best methods and so on, during different parts of the year. They work, as previously described, in two villages as a rule, and are supervised, almost daily, by an agricultural assistant who is responsible for a number of villages. Their pay is Rs. 9 to Rs. 15, but it is recognised that if they do good work their pay will have to be increased. They are now in demand and are sometimes lent to *Malguzars* and others who are willing to pay and utilise them.

The experimental farms are being increasingly used as demonstration centres. It is, for instance, arranged once a year to bring a large number of cultivators from the cotton tract to the farm at Akola. While this is essentially the annual meeting of the Divisional Agricultural Association, yet a large number of others are called, and come. This is arranged when there is most to see, and the matters to be shown are arranged carefully beforehand. The Railway Companies grant concessions of half fares to members attending these meetings. Similar work is done in connection with other farms. So much is this use of the farms valued that the District Boards are now devoting some of the money formerly employed in paying for young men in the *Malguzari* class at the College at Nagpur, to the purpose of sending cultivators to the various farms.

In this connection may also be mentioned the success in the extension of the use of new ploughs by means of local ploughing matches, for substantial prizes, held in centres where the ploughs are suitable.

In Bombay the development of local demonstration has followed the increase of staff which it necessitates. In practically every district there is now a trained and qualified fieldman,—sometimes a graduate, sometimes not,—who carries on demonstrations on the cultivator's own land, supplying him with necessary outside materials and being present at the critical moment. The chief difficulties are found to be to maintain the quality of the supervision of such work and to train adequately and properly men for such local employment. To have a good supervising staff and well trained men to do the work are considered to be vital to success. At present the training of the men in hand forms the great hindrance to very extensive development. Much and increasing success has been attained, but it is felt that the training of the men required will be among the most important work of the senior staff for years to come.

Mention should be made of the demand which is arising for trained non-graduate fieldmen and also for graduates by local proprietors. So far, as a rule, the demand cannot be filled, but the very existence of the demand is an indication of the value of the local men's work.

Under the Court of Wards in Madras definite demonstration farms have been established on some of the estates where practices are shown which are considered to be practically applicable. The cultivators are invited periodically to inspect, and meetings held for discussion. Considerable success has been attained in several cases.

In the Punjab definite local demonstrations have been undertaken in certain districts, notably Lyallpur, on the interculture of cotton. The agents employed were superior workmen (*Makadams*). Spots were selected all over the district in cultivators' holdings. Cotton was planted by the Department, and the plots were visited periodically with the interculturing implements. The system seems a success, and has certainly shown the people how water can be saved by the method.

Monthly ploughing classes have been held, but the people now prefer that the demonstrators of the Department should go to their villages and train them there in the use of the new plough on their own land. It is intended to extend this system to the limit of the available staff. Classes have also been held in the use of reapers, but here there is less need, as the knowledge of their working quickly spreads.

In Bengal the work of the agricultural station is attracting large number of visitors and local people. The serious damage done by the potato moth has led to demonstrations in the Patna district on the storage of seed potatoes in sand. The original demonstration concerned only fifty maunds stored after harvest, which later, at the time of sowing, showed a profit of R130. The result of this was that in the following year (1910) six cultivators followed the same method, and in 1911 no less than 200 cultivators stored seed potatoes similarly.

In the United Provinces small plots in the hands of cultivators have continued to appear the most suitable for demonstration work, and the use of this method has been considerably extended. As an example, in one district forty members of the agricultural association are carrying out demonstrations. In another case the members of a co-operative bank have very successfully taken up the introduction of ground-nuts and Meston ploughs. Demonstrations of another kind are illustrated by work against the potato moth and sugarcane hopper carried out in a number of villages by assistants of the Agricultural Department.

In the remaining provinces the methods previously described have been continued with, in most cases, an increasing amount of success.

It is again necessary to insist on the vital necessity of the sympathy of the local cultivators having been previously obtained if any success in the direction of local demonstration is to be attained. This, and the extreme importance of having men *specially* trained for this work, are the principal points which the Committee desire to emphasise as the result of recent experience.

Vernacular Agricultural Journals.—The number of vernacular agricultural journals has increased during the past two years, while the old ones issued in the United Provinces and the Central Provinces are still maintained. The latter has now a circulation of 6,000, and has recently been enlarged by the addition of a section on co-operative credit,—while there is now regularly a column for students. The journal in the United Provinces now gives coloured plates occasionally. An independent Hindi Journal published in Benares reproduces the articles from departmental publications and is patronised by the Department. A new vernacular agricultural journal has been established in Bombay. The edition published in Marathi is the property of the Deccan Agricultural Association; that in Kanarese belongs to the Dharwar Agricultural Association. The editing in each case is done partly by members of the Agricultural Department, partly by outside gentlemen interested in the subject. The entire financial responsibility is borne by the Associations in question, but the magazines will pay. They are always illustrated, and cost Re. 1 per annum, including postage. They have been much appreciated, and the combined circulation within eighteen months of establishment reaches between 4,000 and 5,000 copies. This shows the appreciation which a good agricultural magazine obtains, but the magazine must be well edited, topical, up-to-date, illustrated if possible, and the articles must, in large proportion, be practical and hence appeal to the cultivators.

In Madras and in Eastern Bengal and Assam agricultural calendars are issued. These are distributed to every village, and undoubtedly reach into almost every corner of the provinces, and are a valuable means of getting information to a large body of people.

Leaflets and Circulars.—There is nothing new to report under this heading. Leaflets are issued in the same provinces as previously, and the conditions of their value have been well indicated in the previous reports.

Agricultural Shows and Exhibitions.—Additional experience is accumulating with regard to the best method of holding shows or utilising fairs and *melas* held by others.

In the Central Provinces shows are never got up by the Agricultural Department, but local fairs held for other purposes are often utilised for exhibiting things particularly interesting to the tract where they are held. If they are among villages where demonstrations are going on, some of the produce from the demonstration plots is attracted by the offer of substantial prizes. Thus, for instance, in a district where improved groundnuts were being introduced, no less than 210 samples were shown by the cultivators at such a show: in another case, ninety samples of improved sugarcane were attracted. Their educative value is felt to be much increased if the exhibits are limited to special things in which the Department is interested.

In Bombay, where many shows, large and small, have been and are organised by local bodies backed by the Agricultural Department,—there is felt to be a danger of their becoming somewhat uninteresting exhibitions. It is felt that three points must be recognised :—

(1) that the prize list had better be limited to a few crops of importance and capacity for improvement;

(2) that stock makes a more effective show than produce;

(3) that demonstrations of machinery or working implements or methods are essential if a show is to be a success, but as far as possible they should be limited to such as are suitable in the tract.

Prizes are better given in kind than in money.

In Bengal considerable progress in the serious utilisation of the big fairs in the province has been made during the past year. Nearly every big fair in the province has been visited and six circulating exhibits are now kept belonging to the Department. These consist of seeds, implements and manures recommended by the Department. All exhibits are labelled giving directions for use in all the languages of the province. Considerable sales of seeds and some of implements have been traced as a result.

The Committee feel that shows are chiefly valuable for three purposes, and that these should be kept in view and the utility of the shows considered in the light of the way in which they achieve these objects :—

(1) They are a means of demonstrating to a large crowd of people either methods or produce which it is desirable they should see or know about.

(2) They are a means of creating local enthusiasm.

This, however, is of little use unless it can be followed up.

(3) They are a means of bringing a larger crowd of cultivators into touch with the workers of the Agricultural Department than could be otherwise brought together.

This again is of little value unless the touch obtained can be maintained.

Itinerant Assistants.—The importance of the work which may be done by itinerant assistants is being increasingly recognised in the Central Provinces, where sanction has recently been obtained for eight highly paid assistants for the supervision of district work. As elsewhere, it is recognised that these must be among the best men in the Department. While they will overlook experiments, farms, etc., their principal work will be that of supervising the work done by other assistants employed in demonstrations.

In Bengal a similar system is adopted. There are three travelling inspectors,—the most senior men in the Department. There are also seven divisional inspectors who work on behalf of the Divisional Associations and are under the control of the Commissioner in consultation with the Director of Agriculture.

In Eastern Bengal and Assam a scheme has been experimentally sanctioned for the employment of District Agricultural officers, whose duty will be the dissemination of agricultural improvements.

In Bombay the development on the basis of four highly paid divisional inspectors has been continued. These, as previously indicated, are the best men in the Department, and now control fieldmen in every district who are left to follow up and carry out the work they initiate.

In Madras similar lines of development have been commenced and more are in contemplation.

The fact that in all the provinces quoted, development is taking a similar direction would indicate that, after much experiment and fuller experience, the lines now adopted are probably the right ones and possibly the only ones for really effective itinerant work.

Seed Farms and Seed Depôts.—As another Committee is sitting at the present meeting of the Board on this subject, the whole consideration has been left to them.

Utilisation of individual expert cultivators for the introduction of improved methods.—Several interesting cases in which individual cultivators have been utilised in this manner were brought before the Committee. Thus, in the Central Provinces for instance, a number of cultivators from Khandwa were taken to Jubbulpore to show the people the system of planting *kharif* crops in lines with considerable success. The *Kamdar* scheme previously referred to is really the same idea, but in this case the *Kamdar* is permanently employed by the Department.

Vernacular Short Courses.—In the Central Provinces there are special short courses for one or two months at certain of the farms for the *Havildars of Malguzars* and similar proprietors. With them there are often some of the sons of tenants in *malguzari lands.* Thus the transplanting of rice in Chhattisgarh and cane cultivation has been taught to a class during the last year. Similar courses have been held in the sowing of *kharif* crops in lines in Jubbulpore, in sugarcane cultivation and so on. If satisfactory, certificates are given on leaving.

In Bengal short practical courses have been held on one or two of the farms with fair success.

In Bombay the matter is comparatively new. During the last year classes were held in cane planting and *gul* manufacture, and in dairying, and the future promises success in this direction.

The provision of such short courses seems an admirable method of extending desirable practices. It must be recognised, however, that when young men come for a short course, they must be taught and attended to, and that this must be the principal duty of some one on the farm. There is nothing more unsatisfactory or likely to do more harm than for a man to be brought for a course and then neglected or given only the residue of a busy Farm Superintendent's time.

Training sons of Cultivators.—During the past two years a new development has taken place in Bombay in the establishment of a vernacular boarding school for boys, chiefly the sons of substantial cultivators, village *patils*, small land-owners and the like. The school is still an experiment, but as it seems likely to have considerable propularity, it may be described here. The boys taken are from 14 to 16 years old, they must have passed the 4th or 5th vernacular standard and be the sons or cultivators of small land-owners who intend to spend their life on the land. They stay two years, during which half the working time is spent in the field or garden, cultivating and working with their own hands. The other half of the working time is spent in learning ordinary school subjects like writing, arithmetic, geography, all done with special reference to the needs of cultivators. Science is taught almost entirely practically by "Nature study" and the remaining subjects are all connected with village life,—such as village sanitation, care of wells, and the like on the one hand,—and questions of money and credit leading up to co-operative credit on the other. The whole success of such a scheme as this will probably depend on the head teacher who lives with the boys. The school at present promises well, but it must be recognised as still experimental.

Assistance in Marketing.—It often happens that the introduction of a new crop is hindered by difficulty in obtaining the market value for it when marketed. This has, in some cases, been got over in the early stages by arrangements made by the Agricultural Departments, and some examples are worthy of mention here.

A difficulty arose with *buri* cotton, which is a new crop in the Central Provinces, but as a result of the efforts made by the Agricultural Department, the whole which came to market through them, was bought at fair prices by the Empress Mills, Nagpur. In the same provinces a good market has been secured for a better variety of *til*, by arranging through a local association that all should be brought to market on one day.

In Bombay the chief difficulty has been in the marketing of improved or new cotton. In Dharwar, where Broach cotton is a new crop, with a larger ginning percentage than the local cotton, it has been necessary to arrange an auction under the auspices of the Agricultural Department. The whole was well advertised and the cotton was carefully graded by its ginning percentage. The auctions now held for three years have been very successful and the amount sold in one auction has amounted to as much as 10,000 imperial maunds of seed-cotton. Without this it would have been an almost hopeless job to introduce Broach cotton; now it is an established success.

The same difficulty has been met with in the marketing of Gujerat (Broach) cotton, from improved seed, and giving a 5 per cent. improved quality. Now, however, the trade in Bombay have formed a syndicate and promised to buy if the Department guarantee it is from their seed, and if there is at least 2,000 bales. This can be produced during the present season, and, if all goes well, this will do more to establish the status of the improved cotton than almost anything else could do.

Connection with the co-operative credit movement.—Little has been done as yet to utilise the co-operative credit movement for agricultural improvement, but in several provinces schemes are in the air. Co-operative societies for supplying pure wheat seed, a co-operative manure supply association for obtaining oilcake for sugarcane, and many other suggestions are on foot which can only be worked where the idea of co-operation is known and where co-operative credit societies exist. As an example of what can be done, we may quote the Gauria-Kalan Co-operative Bank in the United Provinces, which has taken up the supply of ploughs and other agricultural implements, has the services of a well borer solely at its disposal, has, on several occasions, asked for and obtained the assistance of the Agricultural Department in marketing the produce of its members, has this year made arrangements for the purchase and distribution of a considerable quantity of pure wheat seed, and has practically established the groundnut crop in certain villages. The Committee think that work in connection with such societies, using the knowledge of co-operation obtained by their members, and working by preference among people permeated by their spirit affords one of the most promising fields of activity for those anxious to introduce improvements among Indian cultivators.

Conclusion.—There is little more to say. This report will give evidence that considerable advance has been made in both methods and results. The points which have most struck the Committee as needing to be insisted on at the present juncture, are firstly, the necessity of concentration on such an area as can be well covered so long as the staffs of the Agricultural Departments remain insufficient to cover the whole ground, and secondly, the need for co-relation between experimental work pursued on the farms and elsewhere and the needs of the people as ascertained by the district staff. It is only when these two points are attended to that even the best staff and the most willing workers will produce their greatest effect in actual practice.

SUBJECT IX.—DUTIES OF AGRICULTURAL ASSOCIATIONS IN INDIA.

33. As regards Subject IX the terms of reference to the Committee were :—

To examine and report on the present organisation and duties of the Agricultural Associations, with recommendations for future guidance. How and by whom should control be exercised ?

The Committee reported as follows :—

1. The question of the value of local bodies termed agricultural associations, as means of spreading agricultural improvements, and the lines on which they can best be organised has been before the Board of Agriculture on several previous occasions and the experience which has been obtained in most of the Indian provinces has been summarised in reports issued following the meetings of the Board in 1909 and 1910.

2. The results of endeavours to organise such local bodies have been extremely various. In the Central Provinces on the one hand, they have become, and tend to become even more, the main link between the Agricultural Department and its investigators and the people. On the other hand, in Madras they have been, as hitherto organised and carried on, of a very questionable value, and it is even recommended that, in their present form, they may well be wound up. In other provinces very varying success has been attained. But it is impossible not to recognise that the local energy, the public spirit and the enthusiasm devoted to the associations in those provinces, even where they have been of least use, have been very great and might be valuable assets among the forces making for agricultural improvement.

3. The time seems now to have come when, from a collation of the experiences obtained, lines may be laid down with some certainty on which the best use of local energy may be made and by which the most successful organisations may be encouraged or created. The Committee have preferred trying to do this to merely again giving an account of experiences in different provinces.

4. It might be, and has indeed been asked, whether it is either necessary or advisable to encourage such local bodies as we are discussing. Cannot the Agricultural Department communicate directly with the cultivators ? Is not such communication with, and giving help to, individuals of equal value with work done by and through an association ? The Committee venture to express a decided opinion that while this can be done, while it is possible to deal direct with every cultivator in the districts, yet this is not generally the best or most economical way of proceeding. A local organised body is a far more efficient agent for the introduction of improvements than the few officers of the Agricultural Department working individually can ever be, for being a body of local men, it carries considerable local influence if composed of right people—the members can and do mutually encourage one another, while its educative value in combined work and co-operative effort is, if properly organised, greater than can be realised. Even if the same end can be gained, so far as the introduction of an improvement is concerned, without a local association, the Committee feel that, provided conditions are favourable, a better final result is attained if a local body, as such, takes a share in the matter, as this tends to increase the co-operative spirit of the people and hence the likelihood of permanent advance.

5. Success with such associations can, however, only be reached by following certain lines which can now be laid down with some approach to certainty. However organised, it is necessary that :—

(i) Every local association should have a definite work to do and the members should feel responsibility for taking a share in it. It has not been at all unusual for an association to fail because the members have not been responsible for any work. Again the first question asked by a local body, however got together, is "what shall we do"? Unless the organisers of every single association—generally the Agricultural Department— have definite work which can be placed in the hands of the members, within their capacity, and yet capable of arousing their interest and keenness, it is extremely unwise to attempt any organisation whatever.

(ii) A local association should be composed of men who are really interested—and practically interested—in agricultural improvement in the area in question. Associations have perhaps more often failed on account of the neglect of this matter than for any other reason. The members had but an academic interest in the subject, became members because of social or other reasons, and did not take the work seriously.

(iii) The work of a local association should be regularly inspected, examined, criticised, and the association called together. The Committee wish to lay great stress on this matter, and desire to state that they consider that a considerable part of the increasing efficiency of the system in the Central Provinces has been due to the care which is taken in this matter. It undoubtedly involves on the part of the Agricultural Department (or a central body of some sort) a considerable expense for inspecting officers; but without this, it may be stated with certainty that the result will not be a success except in rare cases. The Agricultural Department must, the Committee feel, aim at having a subordinate staff of high quality for this purpose.

(iv) The members of a local association must, even apart from inspections, be made to feel that the Agricultural Department is interested in them and their work. It is wonderful how regular correspondence, prompt attention, and general evidence of interest and support encourages both the individuals and the associations of which they are members. If Agricultural Associations are to be a success, this must be arranged for at any cost.

6. With these principles accepted and in full operation there is every chance of success; without these the Committee feel that there is very little likelihood of local associations being or doing what they are capable of. The actual types of association may be very different,—and very different types of association *have* succeeded,—but success in every case involves a frank recognition of the principles laid down. And it is hence of the highest importance that associations should not be encouraged or organised unless these points can be arranged for. The Committee feel that in time past there has been, in some cases, a tendency to encourage or form associations when there were no definite lines of work to take up, when the men of whom they were composed were not men really interested, when no regular inspection could be arranged for, and when they were left for long months without any attention. It is not wonderful that such associations died or became moribund.

7. Passing on from general principles to successful applications, the Committee would note that success has been attained by following several lines. In the Central Provinces, where perhaps the most valuable work has been done, the associations are bodies composed of nominees, limited in number, of the district officers for each district. These, say for instance, to the number of thirty, are called together to a convenient centre, appoint a Secretary and are met by a senior officer of the Agricultural Department, usually the Deputy Director, who has a number of pieces of work suitable for their district ready to suggest to the members to take up. These are not experiments but consist in carrying out some demonstration—of new seed, better methods of cultivation and the like—in using their land as a seed farm, in distributing sulphate of copper for treating *juari* seed, in acting as agent for ploughs or in making arrangements for marketing and similar things. Each man with his duties allotted returns home: he is supplied at once with the material he needs, and, thereafter, is visited by an assistant once a month and by the Superintendent of the farm in that circle several times a year. Six months later all the members meet again; the Deputy Commissioner is in the chair; the Deputy Director is again present; the work done is discussed, causes of failure made out, accounts of success recorded, and a new lot of work arranged for, for the ensuing period. Once a year the members of all district associations in a tract are called and meet at a common centre, generally a farm of the Agricultural Department, when experiences can be discussed among a larger collection of cultivators, selected outsiders being invited. All the proceedings in these larger meetings, as well as in the district associations, are in the vernacular.

8. Over and above the points already insisted on, the success in this case may be attributed to the careful selection and nomination of members by the local authorities, to the small numbers of members, who thus esteem membership an honour, and to the lines of work being drawn up and carefully arranged *beforehand* by the Agricultural Department.

9. The Committee do not wish to suggest that the method of organisation just described is the only one which will succeed or which is even the best under all conditions. It is possible, perhaps even probable, that this type of organisation is most suitable where the type of agriculture is backward, or at any rate where there are large numbers of fairly obvious improvements capable of giving large and immediate results. In other cases it may be more advisable to have other units than a district, sometimes even as small as a village. It may (and the method has been successful in parts of Bombay) be wise to have much more independent bodies than those of the Central Provinces. It may be advisable to have a regular hierarchy of associations, from those representing a very small area to one representing a whole province, and so on for many other variations which can only be determined locally.

10. But, however organised, the principles which have been laid down are, in the opinion of the Committee, essential. They venture to hope that the time is now past when Agricultural Associations are created in every district in a province by executive order—heedless as to whether there is work for them or whether they can be instructed and encouraged. If there

is work laid down for each association and its members to do, if they are composed really of the men to whom agriculture is a vital interest, if they can be regularly inspected and meetings held, and if the association and its members can be made to feel that the Agricultural *Department or some central body is continually interesting itself in the work going on* and ready to give assistance whenever required, then it is almost certain that, provided that the local circumstances are properly taken into account, a local body will be created of extreme value for the development of the industry.

In introducing the report, Dr. Mann laid particular stress on the definite nature of the lines laid down in the 5th, 6th, 7th and 8th paragraphs of the report as those on which success with such associations could be reached.

Mr. Moreland, referring to the description, in paragraph 7 of the report, of the associations in the Central Provinces, said they were not really associations but committees appointed by district officers to carry out the work. The ideal type of voluntary association for common measures of agricultural improvement would not submit to dictation or inspection. He pleaded for distinctive names for the two kinds of bodies owing to the danger of drawing false inferences from one to the other based on identity of title. He did not question the value of the "so-called" Agricultural Associations of the Central Provinces.

Mr. Evans explained that they were, in practice, voluntary associations, and displayed independence, but in reply to the President conceded that expenditure on agricultural literature incurred by the Jubbulpore Association was controlled by the Deputy Commissioner.

Mr. Sampson thought the report should have contained more detailed criticisms.

Dr. Mann, in order still further to emphasise the essentials of the Committee's report, then moved a resolution :—" The Board accepts the report of the Committee and would endorse strongly the view that local associations should never be organised or the organisation encouraged unless (1) provision is made for definite work on the part of the local body ; (2) the members are definitely and practically connected with agriculture ; (3) regular meetings and visits from the officers of the Agricultural Department could be arranged for ; (4) the local body can be made to feel that the Agricultural Department is interested in their success :" with an addition proposed by Mr. Stuart to the effect that "the Board consider that where associations have been formed on other lines and have been found to be useless, official support should be withdrawn from them, and a fresh start made on the lines indicated in the Committee's report."

Dr. Coleman seconded this resolution and general agreement was expressed with its terms, but Mr. Heycock proposed and Mr. Woodhouse seconded an amending resolution :—**" That the Board accepts the report of the Committee as far as it goes, but feels that under the terms of the reference the Committee ought to have dealt with the conditions and working of associations and other non-official bodies in each province separately. The conditions of each province vary to such an extent that no general conclusion is applicable to all provinces equally. The Board however consider that where associations have been formed on other lines than those laid down in paragraph 5 of the Committee's report and have been found to be useless, official support should be withdrawn from them and a fresh start made on the lines indicated."**

This, after a short discussion, **was put to the vote and carried.**

SUBJECT X.—DEVELOPMENT OF ORGANISATION OF SCIENTIFIC RESEARCH IN PROVINCIAL DEPARTMENTS.

34. The Board then proceeded to the consideration of the report of the Committee appointed to deal with Subject X.

The Committee consisted of Dr. Barber (Chairman), Drs. Leather and Coleman, Messrs. Barnes, Clouston, Fletcher, Hart, Hutchinson, Plymen and Woodhouse.

The terms of reference were :—

To advise on the general lines on which the organisation of scientific research should be developed in the provinces, the staff required, and how the work between the scientific departments should be distributed.

The Committee reported as follows :—

Before dealing with the specific items mentioned in the reference, the Committee desires to make some general observations on the subject of scientific research. They feel that considerable misconception exists in many quarters as to what is really indicated by the word and have therefore made an endeavour to express their views as to what research is. It is perhaps impossible so to word a definition as to include all the aspects of the subject, but, in general terms, research may be said to consist of all attempts at *adding facts or principles to those which already constitute any science*. It is perhaps unnecessary to emphasise the need of a very thorough knowledge of that science, usually obtained after many years' study, but it is well to bear in mind that research means unremitting toil, frequently extending over long periods of time, together with a considerable amount of discrimination and some power in marshalling facts and generalising from them.

If the foregoing statements are accepted *it will necessarily follow that the individuals capable of* conducting a piece of research are comparatively few. It may in fact be safely stated that the great majority of those who go through a course of scientific study at the Universities are quite unfitted to carry on research.

Applying this to the conditions prevailing in the agricultural services in India, the Committee consider it desirable to draw the attention of the Board to the fact that no special efforts seem to have been made, in the selection of the scientific officers, to include only such as are *fitted for research. An excellent teacher or administrative officer will not unfrequently* be found to be ill-fitted in this special line, and it will be unfair to expect the work done in all provinces to be of equal merit.

But in India the state of our knowledge of the various sciences which are of service in agriculture is so meagre that in most cases a great deal of preliminary investigation will he needed before research can be started. And in consideration of this fact the term may he temporarily worded so as to include these preliminary investigations, and, if this is done, there will be *plenty of research at hand to engage all the scientific officers of the Department*. The Committee is strongly of opinion that in view of the close relationship which exists between research and progress, it is of importance that every encouragement should be given to it. On the other hand the Committee consider that the teaching and routine duties of officers attached to agricultural colleges make such demands upon their time that the ultimate duplication of the senior staff will he necessary, and officers specially qualified for conducting research will have to be recruited where necessary. It is, meanwhile, impossible to lay down any general scheme as to the staff required. This will depend upon the age of an Agricultural Department, the class of subject likely to require investigation and the money available.

The Committee further, while recognising that in the early years of Agricultural Departments few assistants will he fitted for research work in science, consider that every effort should be made to obtain such, their number depending upon the character of the work taken in hand; and they would emphasise the desirability that such assistants should be free from any form of teaching work.

The Committee consider that research work should be as unfettered as possible in every direction. Officers engaged in it should be relieved of other work as far as existing conditions allow. Once a problem is taken up the greatest freedom should be allowed both as to the direction in which that problem should he attacked and as to the carrying out of such experiments as are considered necessary. There is no matter in which individuality and natural tastes play a greater part than in research. As a concrete example, the question of the amount of natural cross-fertilization in a cotton field might be quoted. In Egypt and at Cawnpore a reasonable answer to this question has been arrived at, but the methods adopted could hardly differ more from one another or from the straight-forward method which would suggest itself to most investigators. But suggestions from other officers are especially valuable in all research matters and, with the object of obtaining these, the Committee are of opinion that, *in provincial departments, it is desirable that a Committee of the senior staff should meet at regular intervals to discuss departmental work*, particularly with reference to new lines of work and bringing such results as are of practical utility into effect in the province.

The Committee consider, lastly, that duplication of work in different provinces, that is, the conducting of identical pieces of research, should not of necessity be discouraged. The advantages to be gained, either in confirmation of results or in noting variations or apparent contradictions may prove, in their opinion, of great value.

In introducing the report of the Committee the President proposed to take the report as read. He thought the discussion in Committee took a line other than that required as regards development, the report was somewhat diffuse for discussion and contained a great deal of matter of a controversial nature.

In reply to Mr. Milligan, the President deprecated the discussion of any part of the report in connection with the resolution before the Board and was supported by Dr. Barber, who proposed :—**"That the Board while not prepared to discuss the report of the Committee places it on record."**

Dr. Butler seconded **the resolution** which **was carried without opposition.**

35. Dr. Barber then proposed and Mr. Woodhouse seconded a resolution :—**"That the Board records its opinion that research should be encouraged and that the individual work of the researcher should be as unfettered as possible. It also considers that, in view of the importance of research, it will ultimately be necessary to increase considerably the staff of researchers. Beyond this it is unable strictly to define in advance the lines on which its organisation should be developed."**

This resolution was carried unanimously.

SUBJECT XI.—MAINTENANCE OF PURE SEED OF IMPROVED VARIETIES OF CROPS.

36. There remained for discussion Subject XI which had been considered by a Committee consisting of Mr. Howard (Chairman), Dr. Barber, Messrs. Anstead, Bergtheil, Evans, Hector, Milligan, Parnell, Smith and Woodhouse.

The terms of reference were :—

To report on the most suitable methods for the production and maintenance of the supply of pure seed of improved varieties of crops with recommendations as to the best organisation for carrying out the same, and the Committee reported as follows :—

The Committee consider that the *general aim* to be kept in view in the improvement of crops in India is the replacement, wherever possible, of the existing mixtures by pure types characterised by increased yield and by improved quality.

I.—*Methods of obtaining improved varieties.*

The Committee strongly emphasise the necessity of all work in this direction being based on the study of the methods of pollination of the various crops investigated. It is especially necessary in the case of plants which cross-fertilize that this preliminary work be undertaken, otherwise much time and energy will be wasted in selection experiments and variety trials which cannot possibly yield any useful result. It is desirable further that this preliminary work should be conducted in the tract concerned, as several cases have recently occurred in which climate has considerably modified the usual pollination mechanism. For example, wheats cross to a far greater extent in the irrigated tracts of the Punjab than in the damper regions of India.

Selection.—In the case of self-fertilized crops the comparison of the progeny of single selected plants might easily result in the production of the desired improvement. In this case all that is necessary is to multiply the type and begin the work of seed distribution. In the case of plants which cross-fertilize the procedure is not so simple and special measures are necessary to avoid the consequences of vicinism.

Introduction.—In introducing varieties of crops from other tracts or countries it is necessary to study the constitution of the crop, and possibly to apply methods of selection. The immediate distribution of imported seed is undersirable owing to the possible prevalence of inferior types. Neglect of these precautions in the past probably accounts for the want of results in introducing exotic cottons into India.

Hybridization.—If the desired improvement cannot be obtained by selection, it may be necessary to cross suitable types, and to evolve a new form combining the special characters desired.

Work on the above lines should result in the production of a stable agricultural type, which alone should form the basis of future seed distribution.

II.—*The testing of varieties.*

In the testing of varieties of crops which cross-fertilize there are special difficulties to be borne in mind. The seed of different varieties grown side by side cannot be employed for the production of pure seed. For the same reason variety trials should not be conducted on seed farms unless special precautions are taken to isolate the plots from which the pure seed will be derived.

III.—*The maintenance of pure types.*

The Committee lay great stress on the maintenance by the Botanist in each province of a collection of the improved types introduced into general cultivation by the local department. This collection will serve as a source from which pure seed can be obtained whenever it should be necessary to re-stock the seed farms.

IV.—*Distribution to cultivators.*

The Committee are of opinion that the following main principles should guide the work of the Agricultural Department in the growth and distribution of seed to cultivators in India. These are :—

(1) The desirability of concentrating the efforts of the Department on one or two well defined problems at a time rather than wasting its resources on indiscriminate seed distribution.

(2) The desirability of confining the work of seed distribution in any one tract as far as possible to *one* sort and of *systematically replacing* existing mixtures by this pure type. This is particularly necessary in the case of cross-fertilized plants where degeneration through vicinism is of such great importance. The distribution of one sort only has the further advantage of creating large supplies of one particular type and thus forming a *trade centre for this produce* and attracting buyers.

(3) The necessity of utilising to the utmost the present staff and resources of the Department and of supplementing this by enlisting the assistance of leading agriculturists in the work of seed growing and seed distribution in the tracts concerned.

Applying these principles to the present projects in India it was felt that Madras and the Central Provinces supply the most useful examples of successful seed distribution, which deserve the closest possible attention on the part of all concerned in this work.

Among the successful schemes of seed distribution in Madras the replacement of the mixed crop by a pure Karungani cotton in the Tinnevelly District is a notable achievement. This variety, originally found in a pure cotton tract, was tested on the Koilpatti farm and proved to be a great advance on the local mixture. A system of seed distribution was then gradually

built up and at the present time, after five years' work, there are 80,000 acres of this cotton in the district. The Agricultural Department's farm grows sufficient cotton to supply the contract seed growers and buys the *kapas* from these men, gins it and arranges the distribution of the seed to the village depôts before the sowing season. Each depôt supplies two or three villages and a suitable man is selected as the depôt keeper, who retails the seed under departmental supervision at a fixed rate and on a commission of annas 4 per bag. The village is regarded as the unit and every effort is taken to get all the growers in each village to take up the seed. It is important to notice that the procedure follows that of the best seed growers in Europe, and that the seed grown by the contractors is under strict control and comes back to the Department every year. In the Central Provinces equally striking examples are furnished by the Agricultural Department. In the cotton tracts the work of seed distribution is confined to two suitable kinds, and a fairly large supply of seed is produced on the Government farms which is distributed to private seed growers who themselves retail their seed to cultivators. In the wheat growing tracts of this province the efforts of the Department are concerned with distributing a pure, soft, white wheat to selected *Malguzars* who are members of the District Agricultural Associations. Each man agrees to sow a large area and to provide suitable arrangements for storing seed and threshing the crop. In this way it is expected that beginning from a central farm a gradually increasing area of the wheat tract will be sown with one wheat only to the great advantage of the growers and the trade.

The main features of the above examples are that seed distribution starts from a central farm and gradually spreads outwards. The assistance of the best farmers is enlisted, the seed is fully charged for and the work is conducted in tracts where markets already exist for the produce.

In concluding its recommendations on this portion of the subject the Committee desire to draw attention to the desirability of some botanical control in the work of the central seed farms, and suggest that, whenever possible, these should be visited by the Botanist. The Committee also wish to emphasise the need of great care in seed growing, both as regards cultivation and also as regards contamination from such sources as the seed of a previous crop, the dung of animals, irrigation water and the like.

V.—*Marketing the produce.*

The Committee desire to mention the importance of this subject in the work of seed distribution, and especially where distinctly improved crops are being grown. It is felt that, at the beginning at any rate, it is not always possible for the people to get the real value of their produce and for the improvements to be fully recognised by the trade. At present quality by itself is sometimes a secondary consideration, but if combined with yield the chances of successful introduction are greatly increased. The need is felt of some means of finding the real market value of the produce, and it is suggested that the best way of doing this is to send to the best market and sell for several years there sufficiently large consignments of the produce.

In carrying out experiments of this nature, however, three points must be remembered :—

(1) That a single consignment in a large market or exchange is unlikely to attract much notice unless special attention is drawn to it.

(2) That single occasional consignments do not fetch the same price as produce of recognised value known to be regularly obtainable in large quantities.

(3) That as in the future the marketing of this produce must be in the hands of the local buyers and agents, it is advisable where possible to enlist their help and carry on this work with their co-operation.

Mr. Howard having read the report, Mr. Burt suggested that the Board should accept the report, and should lay stress on the extreme importance of section V, concerning the marketing of produce.

Mr. Howard objected to attention being thus drawn from the main subject of the report.

Dr. Butler agreed with Mr. Howard and emphasised the value of every part of the report, instancing, particularly, that relating to the introduction and distribution of mixed types, and referring to "Java" indigo. Mr. Bergtheil agreed that Java indigo was probably such a mixture.

Mr. Burt said that the question of marketing might be neglected in some provinces.

The President suggested that this could be brought to the notice of the Local Government, and laid stress on the value of the whole report.

A resolution proposed by Dr. Mann and seconded by Mr. Sampson :— **"That the report be accepted as it stands" was adopted by the Board.**

37. The Proceedings closed with votes of thanks to the President, Dr. Butler, Mr. Moreland, the Superintendent of the Office of Inspector General of Agriculture (Rao Saheb Nagarji D. Naik), the senior Overseer of the Pusa Farm (Mr. M. Ikramuddin), and the Superintendent of the office of the Director of the Institute (Mr. C. S. Rao).

38. The Board decided, in the event of the Government of India approving of the holding of alternate meetings in the provinces, to accept an invitation to hold the next meeting (1914) in Madras if such invitation were given.

APPENDIX A.

Subject II:—Programme of the Imperial Department of Agriculture for 1912-13.

I.—THE AGRICULTURAL RESEARCH INSTITUTE, PUSA.

(E. J. Butler, M.B., F.L.S., Offg. Director.)

The scientific work of the Institute for the coming year is indicated under the programmes of the different sections.

Students will be accepted for the post-graduate courses detailed in the Prospectus. In addition to these short courses in cattle and poultry breeding and management, fruit growing, eri and mulberry silk-worm rearing, silk spinning, dyeing and weaving and lac cultivation will be continued.

II.—AGRICULTURAL CHEMISTRY.

(J. Walter Leather, Ph.D., F.I.C., F.C.S.)

1. The work on the availability of plant food in soils will be continued.
2. In relation to moisture requirements of crops, the current work has to do with the moisture conditions necessary to a green manure crop.
3. The investigation on Usar will be continued.
4. The chemistry and manufacture of date palm sugar will be investigated by the Supernumerary Agricultural Chemist.
5. Improvements in the refining of saltpetre will continue to be studied.
6. *Education.*—This requires no special comment and will be conducted according to the lines laid down.

III.—ECONOMIC BOTANY.

(A. Howard, M.A., A.R.C.S., F.L.S.)

1. *Training.*—The training of advanced students in this section will be continued.
2. *Plant breeding and plant improvement.*—During 1912 the following crops will be studied:—wheat, tobacco, oil-seeds and fibre plants.

(*a*) *Wheat.*—The production of improved and rust-resistant types by selection and hybridization will be continued. The co-operative experiments on the influence of the environment on the milling and baking qualities of Indian wheats, which are being conducted in collaboration with Mr. H. Martin Leake, Economic Botanist to the Government of the United Provinces, will be continued. The botanical survey of the wheats of Baluchistan and the agricultural survey of the wheats of Bengal will be completed.

(*b*) *Tobacco.*—The production of new varieties by selection and hybridization will be continued, as well as the testing and curing of the varieties already isolated. The detailed study of the inheritance of characters in tobacco is being continued by the Personal Assistant.

(*c*) *Oil-seeds.*—The study of the oil-seeds of India will be continued on similar lines to those adopted in the investigations on wheat.

(*d*) *Fibres.*—The isolation and testing of pure races of the fibre plants of India will be continued. The study of the inheritance of characters in these crops is being continued.

(*e*) *Fruit.*—The fruit experiments at Pusa will be continued on the lines laid down in the first Fruit Report. During the months, May to September, the work connected with th development of the fruit industry of Baluchistan will be continued.

IV.—MYCOLOGY.

(E. J. Butler, M.B., F.L.S.)

1. *Research and experimental work.*—The work on the wilt diseases of crops will be continued on the lines indicated in the Memoir on pigeon-pea wilt published last year.

The investigation of the fungus diseases of sugarcane will be continued. The chief points of the present enquiry are the spread of red-rot through the soil, the relative immunity of thin canes to this disease, and the study of two undescribed cane diseases.

The study of some fruit diseases commenced last year will be continued, particularly with reference to their control by spraying.

The Supernumerary Mycologist is engaged on an investigation of the root-rot of a number of crops caused by the fungus *Rhizoctonia solani*. This will be continued.

2. *Training.*—This will be continued on the lines indicated in the Prospectus. Short courses will also be given to students taking the fruit growing and general courses and to private students as during the past year.

3. Advice regarding the fungus diseases of plants will continue to be given to other departments, particularly the Provincial Departments of Agriculture and the Forest Department, and to the general public. The distribution of named specimens and other material to provincial colleges and other institutions will also be continued.

4. *The collection and identification of Indian parasitic fungi will be continued.*

V.—ENTOMOLOGY.

1ST SECTION.

(T. BAINBRIGGE FLETCHER, R.N., F.E.S., F.Z.S.)

The study of the insect pests of crops, orchards, gardens, stored produce, etc., will be continued, simple remedies devised as far as possible, and the results published. Assistance will be given, when desired, in directing and co-ordinating the work of Provincial Assistants, in coping with out-breaks of crop pests and in organising exhibits for agricultural shows. Instruction will be given to students requiring a course in general entomology and the series of short courses in lac and silk will continue to be given ; a short course in bee-keeping will probably be added to the list of courses available. Special attention will be paid to the insect pests of sugarcane, cotton and wheat, work on termites (white ants) will be continued and the experiments on bee-keeping will be extended. Issue of coloured *plates and lantern slides of insect pests will be continued, and a series of coloured plates of birds useful to agriculture* is in contemplation. A large volume of facts regarding injurious insects has been accumulated in the last few years and publication of these will be continued in the form of memoirs, bulletins, etc. A revision of " Indian Insect Pests " is urgently required and work on this will be continued, if not already completed.

2ND SECTION.

(F. M. HOWLETT, B.A.)

1. Work on blood-sucking insects, ticks and other similar parasites injurious to man either directly or indirectly will be continued, special attention being paid to the insects capable of transmitting *Surra* and to the life-histories and occurrence of mosquitoes and sand-flies and the means of checking them.

Attention will also be given to the dipterous pests of crops and fruit, and to the application of practical measures to control or minimise their ravages.

During Mr. Howlett's absence a large mass of material for the study of biting flies has been received from various officers of the Medical and Veterinary Departments. A large amount of time will have to be devoted to working through these and to the systematic arrangement of the collection of Diptera.

Instruction of agricultural students in a knowledge of pests of live-stock and poultry will be carried out.

2. In addition to the above, some or all of the following special investigations are proposed :—

(1) Bionomics of mosquitoes, with special reference to the influence of temperature.

(2) Influence of external conditions on the life-history of fleas, with special reference to the question of the degree to which climatic conditions affect the incidence of plague.

(3) *Life-history and habits of Simulium (hill cattle-fly), sand-flies, dung-infesting cattle flies and such house* flies as are likely to be found to be carriers of enteric or similar diseases.

(4) Bionomics of Hippobosca and of certain ticks.

(5) Observations on the responses exhibited by Diptera to chemical stimuli.

The future work of this section will in all probability be adjusted to cover as far as possible the more immediate requirements of Veterinary and Medical Departments as ascertained in consultation with their respective Heads, and until this consultation has taken place no detailed programme for 1912-13 can well be framed. The above programme can therefore be regarded only as tentative.

(Paragraph 1 is the programme submitted by the Officiating Imperial Entomologist during Mr. Howlett's absence in England.)

VI.—AGRICULTURAL BACTERIOLOGY.

(C. M. HUTCHINSON, B.A.)

1. The systematic investigation of the distribution, physiological character, and functions of soil bacteria in India will be continued.

2. A special line of enquiry will be taken up as to the relations existing between the practice of green manuring in India and the activities of soil bacteria.

3. Special problems, such as plant diseases of bacterial origin, will be dealt with as occasion may arise and opportunity permit.

4. The training of the assistants in the section will be continued.

5. The training of students in agricultural bacteriology will be continued.

VII.—AGRICULTURE.

(A. C. DOBBS, B.A.)

1. *Cropping.*—The question of the continuation of the permanent experiments on the present lines will be reconsidered in the light of the experience of local conditions accumulated since the experiments were initiated.

Modifications of cropping necessitated by the increase in the area of low land recently reclaimed on the one hand, and of the size of the Montgomery herd on the other, will be gradually introduced ; the low lying land referred to, by providing a large quantity of fodder crops will, it is hoped, enable a large part of the higher land on the farm to be devoted to direct revenue producing crops.

2. *Pasture.*—Experiments on the improvement of the pastures by systematic grazing and occasional surface cultivation are being considered.

3. *Machinery and implements.*—The use of labour saving machinery will be extended as far as economically possible in order to enable a more critical selection to be made of the labourers employed on the farm.

4. *Breeding herd.*—The improvement of the milking capacity of the Montgomery herd will continue to be the main object in view.

5. *Sheep.*—The value of the Gorakhpur Dumba cross of sheep appearing to have been proved, for this district it is proposed to attempt to fix a pure type of sheep endowed with the valuable qualities of the cross. Material for a study of the behaviour of hereditary characters in crossing sheep will thus be available.

6. *Poultry.*—It is hoped that it will be possible still further to simplify the experiments with poultry.

VIII.—COTTON.

(G. A. GAMMIE, F.L.S.)

1. To visit and advise on points regarding cotton and its cultivation whenever requested to do so by Provincial Departments of Agriculture.

2. The study of the behaviour of Bourbon, *Buri* and such other cottons in non-cotton producing tracts, as detailed in the last year's programme, will be continued.

3. An enquiry on the manurial requirements of cotton will be commenced.

4. Researches will be resumed on the botany of cotton on the experimental station.

APPENDIX—B.

Subject III:—Programmes of the Provincial and Native States Departments of Agriculture for 1912-13.

1.—BENGAL.

I.—ECONOMIC BOTANY.

(E. J. Woodhouse, M.A.)

College.—The organization of the college work will be continued. The laying out of the college grounds will be taken in hand if funds are available.

Botanical investigation.—The work of isolating and testing the economic qualities of varieties of pulses and millets will be continued, special attention being paid to the following species :—Phascolus spp., Glycine soja., Setaria italica. The cultures of Dolichos spp., Stizolobium spp., Vigna catiang., Elcusine coracana and sugarcane will also be continued. *The work on Glycine and sugarcane is being carried on in co-operation with the Agricultural Chemist.*

Crop pests.—Pests will continue to be dealt with as reported. In addition the campaigns against Agrotis Ypsilon on the *tal* lands and the potato moth (Phthorimœa-operculella) will be continued. The investigations on the Dakhina disease of paddy and the Banana disease will also be continued.

Biological teaching.—The supervision of the Biological teaching and the working out of a satisfactory course will occupy a good deal of time. The preparation of a students' hand-book of the local flora and the accumulation of teaching material in the Botanic Garden will be continued.

II.—AGRICULTURAL CHEMISTRY.

(C. Sommers Taylor, B.A.)

Work in connection with the teaching will be augmented during 1912-13 owing to the arrival of a new lot of first year students.

Research work will be carried on as follows :—

(1) It is proposed during next year to carry out experiments on the influence of different factors on the periods of maturity of some of the indigenous sugarcanes of the province.

(2) Work is being carried on on the more important chemical characteristics of certain leguminous plants singly selected by the Economic Botanist to the Government of Bengal. Some interesting results have been obtained up to the present on the constancy of certain of these characteristics, and further work *will be done during the next season.*

(3) Work has been started on the factors determining fertility in various typical soils. The work in hand at present is upon the study of the residual effect of manures in certain soils the past history of which is known.

III.—AGRICULTURE.

(G. Sherrard, B.A.)

In addition to the usual farm work the laying out of the farm and estate will be continued, and it is hoped that the major part of this will be finished during the year. Simple manurial experiments will be carried out, and a certain number of *experiments which have given good results on the other departmental farms will be carefully tested* on the Home Farm. The instruction of students will continue.

IV.—DEPUTY DIRECTOR.

(F. Smith, B.Sc., F.H.A.S.)

There are five farms under the Deputy Director, namely, Dumraon, Bankipore, Burdwan, Chinsurah and Cuttack. In addition to these it is proposed to open farms at Bettiah, Banki and Suri. The *tasar* silk farm at Chaibassa has been abandoned as recommended by the Imperial Entomologist at the last meeting of the Board of Agriculture.

The Deputy Director is at present on leave, but will return in time to carry out his programme in the coming year. It is understood that it is as follows :—

The chief activity for the immediate future will be to apply the results of previous experience in Bengal, namely, to train Superintendents to be economical of labour on large areas while at the same time getting the crops down in seasonable time. Up to 1905 the ideal of the Department was small areas similar to the ordinary Bengal holding, *viz.*, 5—10 acres. On these areas the activity of the Superintendent was successful, and he was able to show satisfactory results, but with increased areas the Superintendents have not been so successful, and I intend with the co-operation of the Director, even at the expense of experimental work, to teach them more economical handling of labour and better disposal of the farm produce. Already we have sufficient definite results to provide work for demonstration by the Agricultural Association for the present. This gives us time to go on with further research work to obtain other data for future work : such useful rotations as jute and paddy and jute and potatoes will be continued. In particular, wheat cultivation in collaboration with the Imperial Economic Botanist, Mr. Howard, is being undertaken.

With Mr. Somers Taylor, the Agricultural Chemist, manurial residues are being studied.

Green manuring will be taken up on larger areas than has hitherto been possible, while cheap agricultural implements, such as Meston ploughs, Hindustan ploughs, sugarcane implements and irrigation pumps will be given a thorough trial on a large scale.

The use of cotton cake as a manure and feeding stuff will be tested.

The useful work of seed supply will be carried out at each centre.

Several permanent improvements will be taken up at Bankipore, Cuttack and Chinsurah.

V.—SERICULTURE.

It is proposed to establish additional central nurseries to take the place of the existing outlying nurseries and to assist the rearers in disinfecting the village rearing houses. A European expert is also being engaged to conduct an experiment in hybridising.

VI.—FISHERY.

The survey of selected districts from a fishery point of view will be continued. Further inquiries will be made into the spawning grounds of *hilsa*, and possibly a hatching station will be started at Monghyr. The question whether carp spawn in confinement will be studied further, and more work will be done in connection with bhericulture.

2.—UNITED PROVINCES.

I.—DIRECTOR OF AGRICULTURE.

(W. H. Moreland, C.I.E., I.C.S.)

The chief developments contemplated for next year are: (1) the opening of an agricultural station in Rohilkhand in the centre of the indigenous sugar industry, the first object of which will be the survey of local varieties of cane considered as sugar-yielders; (2) the establishment of a seed farm at Aligarh, which will in the first instance be used for propagating the cottons and wheats resulting from the Economic Botanist's work; (3) the more general utilisation of the co-operative organisation as a channel of communication with the cultivators.

The following branches of work are not covered by the programmes of the departmental officers:—

Agricultural Engineering.—The officer lent to the Department as Agricultural Engineer having been temporarily withdrawn, investigations on questions connected with water-supply are practically at a standstill. It is hoped that the appointment will shortly be placed on a more permanent footing.

It is intended to try Mansfield's automatic water-finder, which has proved useful in Bombay in the rock-country in the south of the province.

The supply of well-borers to the public will continue on existing lines.

Horticulture.—The stations at Lucknow and Saharanpur will continue to be utilised chiefly as educational and acclimatisation centres, and for the supply of such plants, etc., as cannot be procured from other sources. The station in the Kumaon hills will continue to be utilised for the development of fruit and vegetable growing.

Poultry.—The poultry-farm at Haldwani, in which Government is a partner, will be maintained for the supply of utility birds to the public, and as a training centre for students (should any offer).

II.—DEPUTY DIRECTOR, WESTERN CIRCLE.

(A. E. Parr, M.A., B.Sc., Ph.D., M.S.)

1. *Experiment work on the farm.*—The work on country cotton will be continued on the lines previously laid down. Variety tests of sugarcane, groundnuts, cotton, wheat, juar and maize will be continued. Tillage experiments with wheat, maize, cotton and juar are being carried on.

Experiments in the eradication of deep rooted weeds are going on.

Usar reclamation experiments are going on.

2. *Demonstration work in the villages.*—Following upon results obtained on the Farm demonstrations will go on in the villages to bring out the following points:—

(1) Advantages of Saretha sugarcane over local cane in some districts.

(2) Advantages of white flowered *desi* cotton over the ordinary mixture.

(3) Advantages of sowing cotton and maize in lines as compared with broadcasting.

(4) Advantage of deep ploughing for sugarcane.

(5) Advantage of hot weather ploughing for cotton and wheat.

(6) To show that groundnuts when grown alone or when grown in a mixture with maize is a paying crop.

III.—DEPUTY DIRECTOR, CENTRAL CIRCLE.

(B. C. Burt, B.Sc., F.C.S.)

1. *Cawnpore.*—The permanent experiments at the Cawnpore Farm will be continued during the present year. The results already obtained are being reviewed and published, and the experiments will probably be modified.

Variety tests of wheat, cotton, *arhar* and groundnuts will be continued.

Manurial experiments with cotton, wheat, sugarcane, potatoes and maize are in progress.

Tillage experiments with wheat, cotton and groundnuts.

The experiments in *Usar* reclamation will be continued.

The testing of promising agricultural implements is being continued.

2. *Orai.*—Varietal tests of wheat, groundnuts, *arhar*, gram and juar will be continued. Cultivation experiments with these crops are also in progress on the four principal types of Bundelkhand soil.

Experiments with miscellaneous plants for waste land are being continued.

Experiments in the eradication of "kans," a deep rooted grass forming a permanent difficulty in Bundelkhand cultivation, are being continued.

3. *Atarra*.—The Atarra Experimental Farm has recently been opened in a typical "Parwa" soil tract in a new canal area. The farm has only been partly laid out and equipped and preliminary experiments will be limited to a study of the increased variety in cropping rendered possible by the introduction of canal irrigation.

Demonstration work will be chiefly directed along the following lines :—

(1) Extension of Muzaffernagar wheat in suitable areas.

(2) Introduction of groundnuts and extension of groundnut cultivation where already introduced.

(3) Extension of Jaunpur maize in suitable areas.

(4) Advantages of hot weather ploughing for wheat.

(5) Advantages of sowing maize at regular intervals over broadcast sowing.

(6) Demonstration of the use of various agricultural implements at agricultural shows and in connection with implement sub-centres.

(7) Supply of early ripening *arhar* to suitable districts.

(8) The supply of sound wheat seed in parts of Bundelkhand if circumstances still show it to be advisable.

(9) Further information will be collected with reference to the potato-moth, sugarcane-hopper and rice-bug, and demonstrations of methods of control given where possible.

(10) Demonstration in the removal of kans by heavy ploughs.

Much of the demonstration work will be in connection with Agricultural Associations and Co-operative Credit Societies. One District Association is doing useful work and several smaller societies recently formed in another district promise well.

IV.—ASSISTANT DIRECTOR, EASTERN CIRCLE.

(L. C. Sharma, M.R.A.C., P.A.S.I.)

Varietal experiments with—

(*a*) *Sugarcane*.—To test their relative merits as sugar yielders. *Reora* of Benares, *Kuswar* of Partabgarh and *Mango* of Shahganj have given the best results so far. These will be planted again and the seed canes from them will be distributed among cultivators who are desirous of trying them.

(*b*) *Paddy*.—To determine their suitability to the locality.

(*c*) Groundnuts „ „ „ „

(*d*) Maize „ „ „ „

(Jaunpur maize has so far given the best results.)

(*e*) *Sann hemp*.—To determine their commercial qualities.

(*f*) *Wheat*.—To determine the best wheat from milling point of view. These experiments are conducted under instructions of the Economic Botanist.

Miscellaneous crops.—Such as Jaipur *bajra*, Farrukhabad potatoes and Mauritius canes, which have given encouraging results so far, will be tried on a larger scale.

Cultivation experiments with paddy crop.—Different methods of cultivation as to sowing and planting now in general use will be compared till some definite results are obtained.

Manures.—The trial of Ammonium sulphate, cotton cake and certain other manures, such as *nim* cake and farm-yard manure on sugarcane, will continue. The green manuring experiments and trial of *nim* cake on potato crop will continue. *Nim* cake is the cheapest manure in this locality and has given very good results.

Barren land.—The trial of gypsum for reclamation of alkaline lands (*Usar*) so as to render them fit for growing trees on them will continue. The effect of this manure on *shisham* and *mahua* plants is a very marked one. The experiments in ravines will be kept up on the lines mentioned in the 1908 programme.

Implements.—Efforts will be made to get the cultivators familiarised with the use of the improved implements.

Seeds.—Collection and distribution of selected seeds through the agency of seed depôts will be continued.

The business at seed depôts has constantly been increasing and a new depôt at Benares has been added to the list this year.

Demonstrations.—Agricultural demonstrations will be given in shows as far as possible.

Insect pests and fungoid diseases will be noted, their specimens collected and examined for identification. Practical measures will be taken for combating the grass hopper, white-ants, rice-bugs and potato-moths.

Hot weather tillage.—These experiments gave very good results in 1910-11 on the Partabgarh Farm, but were not continued this year owing to press of other work. These will be taken up again next year.

Eradication of Rahi weed by ploughing up the land with Watt's or Turnwrest ploughs, picking out the roots and runners of the grass and burning them on the spot will continue.

Publication of a monthly Journal in vernacular will be continued.

The Benares Agricultural Station is being equipped and the uniformity of the soil is being tested.

V.—ECONOMY BOTANY.

(H. M. Leake, M.A., F.L.S.)

1. Work on cotton crop is being continued on the same lines as hitherto, and it is hoped that the earlier improved forms will shortly reach a stage which will make extended cultivation and field tests possible.

2. The classification of the provincial wheats will be continued on the lines laid down in the previous programme.

3. The co-operative experiments on the effect of environment on the milling and baking qualities of Indian wheats which are being conducted in collaboration with Mr. A. Howard, Imperial Economic Botanist, and of which the earlier results are now in course of publication, are being continued on an extended basis.

4. The examination into the forms and distribution of Agave within the province will be continued.

5. The attempts to profitably establish lac on the *dhak* of *Usar* land which have been carried out during the last four years indicate small prospect of ultimate commercial success but are being continued.

6. The supervision of the biological side of the college continues.

VI.—AGRICULTURAL CHEMISTRY.

(G. Clarke, F.I.C.)

1. The supervision of the chemical side of the college.

2. The investigations on the sugarcanes of the provinces which are being carried out at the Partabgarh Station in conjunction with the Assistant Director. This work consists mainly of the systematic testing of 25 or 30 of the most promising varieties with special reference to the outturn of sugar per acre, composition and purity of the juice and period of ripening.

3. An investigation of the chemical side of the quality of Indian wheats at the request of the Economic Botanist and the Imperial Economic Botanist.

4. An investigation, in conjunction with the Deputy Director in charge of the central circle, by order of Government on the effect of fermentation on the solubility of the phosphates of bones.

5. The glucoside occurring in *Tephrosia candida*. The practical part of this work will be carried out by the Lecturer in Chemistry. It is considered important that the teaching staff in their leisure time should be given a piece of purely scientific research not requiring continuous attention in order to familiarise them with the modern methods of research.

3.—PUNJAB.

I.—DEPUTY DIRECTOR.

(S. Milligan, M.A., B.Sc.)

1. *Gurdaspur Agricultural Station.*—Work on the organization of this station was begun in September 1910. The preliminary work of levelling, laying out roads, etc., has been almost completed, but the buildings have not been begun.

Soil tests will be undertaken during the current year, but a beginning of some of the main experiments will be made. The land is divided into two areas—(*i*) under dry cultivation, (*ii*) under irrigation from wells. The contemplated experiments include soil cultivation, manuring and testing of crop varieties. The main crops will be wheat, maize, sugarcane, gram and the summer pulse crops. A collection of varieties of cane from different parts of India is being grown.

2. *Distribution of American cotton seed.*—Owing to the high prices ruling for *desi kapas*, the economic advantage of growing better quality cotton is at present doubtful. The area under cotton grown from seed distributed by the Department remains stationary.

Distribution of American cotton seed will be continued.

3. Progress with regard to distribution of machines and implements continues to be satisfactory. Sales are conducted entirely by private firms.

There is now less demand for practical classes at Lyallpur as new purchasers are learning from their neighbours. Reaping machines are nearly all bought co-operatively.

It is proposed to continue the special reaping class before harvest and to inspect the work of new purchasers of ploughs, reapers and winnowers.

4. Practical demonstrations at cattle fairs will be continued.

5. Organized village demonstrations of the value of inter-cultivating the cotton and maize crops have been undertaken for the first time in the Lyallpur District. It is proposed to continue this work and extend it to other districts where conditions are favourable. It is also proposed to give village demonstrations of the value of ploughing in green crops in canal irrigated districts.

6. *Well-boring.*—The full staff for the 20 well-boring plants has been engaged and trained.

There is not much demand for trial borings, and the work up to date has consisted of tubing existing wells. Considering that the staff is entirely new to the work, operations have been, on the whole, satisfactory. The demand for borings has up to date kept the staff fully employed.

7. *Reh.*—The question is in the hands of the Agricultural Chemist, Punjab.

8. *General.*—The subordinate staff has been somewhat strengthened during the last two months, but still lacks experience and the development of the work outside the agricultural stations will necessarily be guided by the progress made by them.

II.—AGRICULTURAL COLLEGE AND CHEMISTRY.

(J. H. Barnes, B.Sc., F.I.C., F.C.S., A.R.I.P.H.)

The educational duties connected with the Agricultural College will be carried on. These will be extensive, as the session 1911-12 is an important one, for it constitutes the third year of the College and at its end the Diploma examination will be held.

Chemical Work.

1. General agricultural analysis for the Department and the general public.

2. The programme submitted in 1910 has only been carried forward so far as the chemical examination of the alkali affected areas of the Punjab is concerned, the nature of the salts and their extent. This curtailment of work has been necessary on account of inability to secure laboratory staff on the sanctioned scale of pay. Improved prospects have been recently sanctioned (September 1911) and laboratory assistants will be entertained as soon as possible. It is proposed to undertake field reclamation experiments in which mole drainage by steam tackle will be used. This scheme at present awaits confirmation by the Irrigation Department, as some doubt exists whether the tackle can be moved about the colony. The proposals will then be forwarded to Government and an application made for funds to carry out the work, which it is hoped will be in hand by the cold weather of 1912-13. The experiment will be confined to the canal irrigated areas where the land is commanded by irrigation water. A suitable site has been surveyed. Full records will be kept of the experiment, the quantity of water required to remove the salts, the time taken and the quantity of salt removed. The experiment will be planned to extend over five years, and will include cropping experiments.

One of the features of the problem in the Punjab is the lack of drainage contour, and the experiment will include methods for dealing with the removal of the saline drainage water.

Several subsidiary investigations connected with the accumulation of these salts in stiff soils and clay beds and the nature and quantity of salts taken up by crops or affecting their germination on the experimental area will be put in hand as soon as opportunity permits.

3. An analytical survey of the sugar values of canes in the Gurdaspur district will be carried out.

4. Analyses and advice for the Department of Industries with which the Agricultural Department in the Punjab is now amalgamated.

5. Experiments connected with the seepage of canal water. The services of the Agricultural Chemist have been requisitioned by the Irrigation Department in the solution of the problem. A line of experimental enquiry has been planned out in conjunction with the Superintendent of the Canal Workshops.

6. The valuation of the river silt as deposited by the irrigation canals taking water from the rivers Jhelum and Chenab.

III.—ECONOMIC BOTANY, PUNJAB, LYALLPUR, FOR THE YEARS 1912 AND 1913.

(D. Milne, B.Sc.)

Most of the time will be taken up by teaching duties in the College.

Wheats.—The wheats classified by the Imperial Economic Botanist have been multiplied to a field scale. They have been tested on lands of fairly regular quality, and notes of their comparative qualities have been recorded. The wheats have now been handed over to a Committee composed of the Deputy Director of Agriculture, Professor of Agriculture and Economic Botanist, to discover their relative suitabilities for growing in various districts of the province.

Small plots of these wheats will still be grown in the botanical area in order to supply pure seed of the types if required at any future time. Several new types of wheat beyond those classified by Mr. Howard have been discovered and these will be tested in due course. A systematic search for new types will be continued. Some crossing has been done and work in connection with these crosses will be continued.

Cottons.—The results of the past few years' experiments show that kidney, spence and caravonica tree cottons, Egyptian cottons, Buri and Cambodia cottons are failures here. The most suitable cottons for the Punjab at present appear to be acclimatised American cottons and indigenous cottons.

From a large collection of cottons selections have been made on the lines laid down on pages 5 and 6 of the Lyallpur Agricultural Station Report for 1908-09. Some of these selections have been valued above middling Americans by the British Cotton Growing Association, Liverpool, and by the Chamber of Commerce, Bombay. Several selections have been handed over to the Professor of Agriculture for trial on larger areas before being finally recommended to cultivators. Further selections will be made.

It is important to know, if possible, the approximate rapidity with which natural crossing takes place in cottons, as this may seriously affect the distribution of improved seeds. Some observations have been made and it is hoped that it will be possible to give more attention to this point.

A collection of the cottons of the Punjab and North-West Frontier Province has been made and sorted down to a number of types. Specimens of these are now with the Imperial Cotton Specialist for opinion. It is hoped that the survey of these cottons will be finished soon.

Cassava.—Cassava has been found to be a failure as a famine crop in the Punjab, and experiments have been discontinued.

Jute.—Good fibre has been grown at Lyallpur, but the high price of labour and the low outturn of fibre got from ordinary zamindari lands make the jute crop much less profitable than the ordinary crops grown here. Experiments have therefore been stopped at Lyallpur.

Groundnuts.—A collection of the groundnuts of Bombay was obtained, and trials have been made at Lyallpur and Rewari. They were a failure in Lyallpur, but did better in the sandy soils near Rewari. Further trials will be made near Rewari and elsewhere.

Date cultivation.—The western side of the province appears to be well suited for date growing, and some good dates have been grown in Multan, Muzaffargarh and Dera Ghazi Khan districts for a long time past. When properly looked after in a suitable locality the crop appears to be an extraordinarily profitable one. At present the average quality of the date fruits grown is very poor owing to the trees having been grown from the seeds. No hand fertilization is done; therefore about 50 per cent. of the trees are males. The Government tax on fruit-bearing female date trees in the three districts abovenamed is estimated at about Rs. 71,419 per annum. So that if hand fertilization is introduced and the useless males are replaced by date-bearing females, there would be a gain of approximately Rs. 71,419 per annum in Government revenue with practically the same number of trees growing as at present. It is also estimated that the value of the average quality of the fruits can be multiplied two or three times by planting suitable offshoots, and that the area under cultivation can be very largely extended. Work on improving date culture has been started, and will be continued as far as time and staff will permit.

Cryptostegia grandiflora.—Experiments in growing this new rubber plant have been started, and will be attended to as far as possible.

Fruit collection and experiments.—A collection of fruit trees of the province has been started, and small variety and cultivation experiments on fruits on the lines of those of the Imperial Economic Botanist have been laid down chiefly for the information of students. These will be continued.

Teaching collection.—A collection of plants of biological interest or economic importance has been started and will be added to.

IV.—AGRICULTURE.

(W. Roberts, B.Sc.)

Most of the time will be taken up by teaching duties in the college.

It is expected that a vernacular course of about six months' duration or less will be given shortly and as such a course will be almost entirely in agriculture, personal attention will be essential.

2. The students' farm has now attained its final area of 40 acres. It has been almost completely laid out in plots for students, demonstration areas for showing various crops, methods of cultivation, etc.

3. The Lyallpur Agricultural Station is also under the charge of the Professor of Agriculture. The experiments detailed in the cropping scheme will be continued, the chief items being—

(a) Green manuring experiments. Very hopeful results are being obtained from these, and it is proposed to continue and extend them.

(b) Comparison of desi and furrow turning ploughs.

(c) Sub-soiling for sugarcane and cotton. Results have been inconclusive in the past owing probably to the area selected being unsuitable.

(d) Manurial experiments. The $Ca(NO_3)_2$ experiments will be discontinued, as there is no likelihood of this manure paying in the colony. Other manures are being tested with a view to getting more information about the soil.

(e) Water requirements of crops. It is hoped that this work can be taken up shortly as soon as the farm water-supply is in a satisfactory state.

(f) Variety experiments chiefly with wheat and cotton on a field scale.

Wheat.—The Punjab wheats handed over by the Economic Botanist will be grown again. Numbers 1 to 7 have been discarded. The remaining 18 types will be grown at least in one-acre areas. Types 9 and 11 appear to be the most suitable for the western canal colonies, and are being grown in large quantities.

Cotton.—Six American and three *desi* cottons have been handed over from time to time by the Economic Botanist. Of these four American and two *desi* varieties are still grown. Types Nos. 3 F and 4 F (American) are grown in areas of eight acres each and the others in one-acre areas only as in the case of wheat. The agricultural properties of these varieties are being observed, and it is hoped to get definite information shortly about the water requirements of these varieties as compared with the ordinary varieties grown by the zamindars in the colony.

(g) Miscellaneous experiments, such as spacing and thinning of crops, etc., etc.

4. *Trials of new implements, etc., will be continued.* The machinery depôt work has now almost entirely disappeared, as private firms are dealing in almost all the implements recommended by the Department.

5. Poultry breeding.

Exotic breeds have done badly and do not appear to be able to stand the hot weather of May and June. The *desi* varieties will be studied further with a view to improvement by selection and possibly crossing with the exotics.

4.—BOMBAY.

I.—DEPUTY DIRECTOR, BOMBAY PRESIDENCY.

(T. F. Main, B.Sc.)

Crops.

1. *Cotton.*—The remarks made in the last programme regarding the objects aimed at in the work upon this crop hold good, but there has been a considerable development in introducing improved forms into general cultivation among ryots. The most important steps taken in this respect have been in co-operation with the Bombay trade who, as the result of information published by the Director of Agriculture, summoned a meeting of its members representative of the leading cotton associations in May last at which the Director and the Deputy Director were present to consider an elaborate scheme of controlling large areas of land in several parts of the Presidency where improved seed and scientific methods of cultivation would be adopted and the whole kept under close supervision.

At the meeting in question it was decided to make a start at one centre, *viz.*, in the neighbourhood of Surat, and the general arrangements agreed upon may be summarised as follows :—

1. That the representatives of the Bombay cotton trade would form a syndicate whose special function would be to assist in the introduction of improved cotton into general cultivation on a large scale by rendering special assistance in the marketing of the produce.
2. That provided the Agricultural Department could arrange to have 8,000 acres sown with improved seed or at least sufficient area to supply a minimum of 2,000 bales of cotton, the syndicate would purchase the seed cotton at a rate of 5 per cent. above the current market rate for local cotton.
3. That provided the scheme were found to work well, the syndicate would be willing to contribute towards the establishment charges incurred in connection therewith.
4. That the Department should purchase back the seed contained in the seed cotton bought by the syndicate.

Accordingly the Department has distributed 162,418 lbs. of seed among several groups of villages in the neighbourhood of Surat, and it is estimated that an area of 10 to 11 thousand acres has been sucessfully sown with this seed. It is anticipated that the departmental control of this work will absorb a large share of time.

A beginning has been made in Khandesh to distribute seed of Roseum cotton on a large scale, but the present unfavourable season will put a check on this work.

Similar work is being done with Broach and Cambodia cottons in the west and east respectively of the Southern Maratha country, and a very successful auction sale was again held by the Department in the month of May last at which cultivators of Broach cotton secured handsome prices for their produce.

2. *Wheat and Jowar.*—Work on these two crops continues on the lines explained in the previous programme, but there has not yet been time to produce improved strains among the varieties of these crops.

3. *Groundnuts.*—Work in Guzerat and Khandesh has reached the stage when the most suitable variety for the local conditions prevailing in these tracts has been definitely ascertained. This is Spanish peanut, and its special advantages are (1) early maturity which enables its cultivation on the rainfall alone without irrigation, (2) relative cheapness in harvesting operations owing to its habit of concentrating all the nuts close round the base of the plant. The best variety for the Southern Maratha country which has a longer season has still to be ascertained.

4. *Tobacco.*—The qualitative experiment with potash manures referred to in last programme has been started and American and Turkish tobacco varieties suitable for cigarette purposes are being tested on the Nadiad Farm. Cultivation under shade showed that the texture of the leaf could be profoundly altered, but it is considered premature to follow up this line of work until the above experiments have yielded definite results; moreover, it would appear that the expense of shade cultivation is prohibitive.

Progress in barn curing is checked owing to the need felt for an expert curer.

5. *Potatoes.*—Experiments with a great many varieties of potatoes from different parts of the United Kingdom and India have been conducted at Belgaum and Dharwar, but it appears that none of these maintain their high qualities and hence fresh seed is required to be imported at short intervals. On the other hand fresh Italian seed which is commonly used by cultivators gives very good results, and as there is an already existing import trade in this variety it does not seem possible to materially improve upon the seed supply of this crop. Cultural and manurial experiments upon this crop are being continued, but no striking results have been obtained other than those previously reported.

6. *Other crops.*—Selection with the principal object of increasing the prolificness of a number of other crops, such as maize, *tur*, *til*, gram, castors, etc., is in progress on several farms.

7. *Tillage.*—Deep cultivation or ploughing deep with an iron plough which inverts the soil has been under investigation for some years at Surat and Dhulia and more recently at Dharwar, and the general conclusion arrived at so far is that black cotton soil cannot with advantage be so treated in preparation for cotton provided the land is in clean condition. The reason for this is that the land cannot be again reduced to the necessary state of tilth before the season for sowing arrives, even though the ploughing is done 6 months before that time; and the result is that the crop must either be sown in a rough seed bed with consequent bad germination or the sowing deferred to a late date which is generally not desirable. Black cotton soil, moreover, is very retentive of moisture and in a very wet year ploughed land is apt to hold too much moisture which acts adversely on the proper opening of the bolls. These advantages are not felt so much in the case of cereal crops such as Jowar.

Better results have been obtained on rabi crops such as wheat at Dharwar and Gadag, but this is to be expected as the land remains fallow during the rains and hence a good seed bed can be prepared. In the case of this latter crop an effort is being made to apply the principles of "Dry farming," but it is yet too early to report results.

8. *Rotations.*—The most effective rotation crop on the black soil of Surat appears to be groundnut. Its effects are very marked for at least two years on the succeeding crops of cotton and jowar. In 1910-11 a dry crop of jowar taken after groundnut yielded at the rate of 2,500 lbs. of grain and 6,000 lbs. of kadbi. In Khandesh *til* appears to be one of the best rotation crops for cotton, but it is rather a risky crop. Bare fallow was not such a profitable rotation for cotton as *bajri*, *udid* or *til* in Khandesh last year. It has further been proved that in Khandesh excellent crops of cotton can be raised for at least four years continuously without any rotation.

9. *Manures.*—Among bulky manures (upon such crops as cotton, maize or jowar) the most promising results have been obtained with poudrette and *mohra* refuse. Efforts to introduce the former among cultivators have not been rewarded with much success owing to the prejudice against its use, but it is hoped to gradually wear down these objections by demonstrating the value of this manure upon the departmental farms. Owing to the high price of cake manures experiments with these upon ordinary dry field crops are being discontinued. Among artificial manures nitre appears to be the most effective, but at present prices it barely leaves a margin of profit on dry crops.

10. *Implements.*—One of the fundamental difficulties in the path of agricultural improvements in this Presidency is the foul condition of the land which is hide bound with deep rooted tenacious weeds over vast tracts in all parts of the cultivated area. Hundreds of iron ploughs have been introduced by the Agricultural Department, but although these do good work they not infrequently prove inadequate when attempting to clean such lands for the first time; moreover the supply of cattle is not sufficient to enable cultivators to use these implements to the full extent. It has indeed been realized for some time past that mechanical ploughing in some form or other has become a necessity. Steam ploughs would probably be the most suitable plant for this purpose, but they require a large capital outlay and hence by way of making a beginning it was decided to introduce one of Messrs. Bajac's ploughs from France where they had been seen by the Director of Agriculture. These ploughs are made on the balance principle and are drawn alternately by the cable attached to two windlasses at either end of the field which are worked by bullock gearing; this gearing is mounted on a wheeled carriage which runs on steel rails. This plough has been found to do excellent work penetrating fully 16 inches deep, whilst the width of the furrow is also about the same dimension. It is but natural that a plough worked in this way should travel slowly, but slowness seems to be its only serious defect. About one-fourth of an acre can be ploughed in the course of a working day of 8 to 9 hours. One man is required to stear the plough, while one pair of bullocks with their driver is required at each gearing. The cost of this plough complete with gearings is Rs. 3,100 landed in Bombay, and it is estimated that the cost of ploughing an acre of black cotton soil 16" deep is Rs. 22 as against Rs. 15 for ploughing with a direct drawn iron plough which would not go nearly so deep, or Rs. 40 for digging by manual labour. It is proposed to obtain other tillage implements such as cultivators and harrows and to have these worked by the same gearing, and this will solve one great difficulty hitherto experienced, *viz.*, the impossibility of working any implement on recently ploughed black cotton soil owing to the inability of cattle to walk over the huge clods. Large cultivators have already shown their appreciation of this implement, and arrangements have been made to hire it out for a monthly charge of Rs. 100 including a man in charge on, say, Rs. 12 per mensem.

11. A mowing machine of the "Thistle pattern" manufactured by Messrs. John Wallace & Co. has been introduced into Lower Guzerat and a native firm has taken up the agency for these machines. This machine is substantially built and costs £13 in Glasgow. It was found possible to cut an area of 4 acres in 8 hours with a good pair of cattle.

12. Work will be continued in regard to finding out the most suitable type of plough for various tracts in this Presidency, and the value of the "cultivator" as a substitute for the plough under certain conditions will be studied.

13. *Well-boring.*—This work will be greatly extended in Northern Guzerat on account of the present famine conditions prevailing in that tract: at present there are 8 sets of Cawnpore apparatus at work and steps are being taken to add another 20 sets. This work is proving very successful in certain localities and good supplies of water are being tapped at depths varying from 50 to 100 feet below the well bottoms which are themselves 50 to 60 feet below ground level.

14. *Preventive Entomology.*—Campaigns against the rice grass-hoppers at Belgaum have been carried on both last season and in the current season with very considerable success. The method of bagging has been adopted throughout and the work has been financed largely by local subscriptions and partly by Government. Similar work has been carried on against the Deccan grass-hopper (*Colemania sphenarioides, Bol.*), but with relatively less success. However the work will be continued until definite conclusions have been arrived at as to the efficacy of bagging for this grass-hopper.

15. The system of destroying hairy caterpillars (*Amasacta morrie*) by a series of light traps has been adopted, but there seems to be an objection to this practice in so far that it attracts large numbers of moths some of which do not fall into the traps with the result that the pest is liable to be subsequently worse near the spots where the lamps were situated.

Attempts are being made to combat white-ants by means of the white-ant exterminator which is said to have given good results in South Africa, but no definite results have so far been obtained.

17. *Poultry.*—Experiments with Partridge Wyandottes and White Orpingtons at Surat indicate that these breeds are delicate and only moderate layers under the conditions of that place; these trials will be continued and perhaps other breeds will be substituted for those abovementioned.

Practical District work.

18. This takes the form of holding shows and demonstrations at various places throughout the Presidency and also of seed and manure distribution both on sale and gratis and the giving of advice to land holders and cultivators on such questions as bringing land into cultivation for the first time, green manuring, etc. The general conclusion about shows which we have arrived at is that they are usually very expensive in addition to requiring a lot of labour and time and are associated with too great an element of *tamasha* so that the practical results are relatively small. On the other hand the holding of demonstrations on farms and in the vicinity of large fairs affords a ready means of bringing the Department into touch with the maximum number of *bonâ fide* cultivators at the minimum expense, and hence it is proposed in future to hold fewer shows and develop the system of demonstrations. In addition to these central demonstrations it is arranged from time to time to send a demonstrator on tour to a number of villages to demonstrate any particular point, as for example steeping of jowar seed to prevent smut; this latter method of demonstration if done at an opportune time is perhaps the most effective means of driving a valuable piece of information home to the cultivator.

19. Another useful piece of work done in connection with shows and central demonstrations is to secure a piece of land in advance near the site and there lay out a series of plots illustrating the advantages to be derived from using good seed applying artificial manures or adopting improved method of cultivation. On a limited scale we have offered prizes for the best cultivated fields sown with departmental seed.

Steps are being taken to introduce the excellent method of straight drilling seed practised in lower Guzerat into the Southern Maratha Country. For this work the bullocks as well as the driver have to be carefully trained and hence a young pair of cattle have recently been broken in on the Dharwar Farm and trained in this method by a Guzerat expert.

20. *Eri-culture.*—Experiments with this industry have been checked in the current season owing to the famine conditions prevailing in Guzerat.

II.—AGRICULTURE.

(J. B. KNIGHT, M.SC.)

Sugarcane.

(A) Continuation of the permanent manure series for testing mineral supplies of nitrogen, the value of phosphatic and potash manures and the best combination of concentrated and coarse manures under the first.

Sulphate of ammonia has been found to be a valuable source of nitrogen for sugarcane. It pays best when one-half of the usual amount of nitrogen as oil-cake is replaced in the form of the sulphate of ammonia. This means a dressing of 3 cwts. per acre.

Sulphate of potash increases the outturn of gul to a considerable extent. On the last point it is found that it is a question of relative prices.

The farm yard manure (coarse manure) can be reduced to 12 or 15 carts and the remaining nitrogen requirements given as cake in places where the price of nitrogen in farm yard manure is higher than that in concentrated ones. On the other hand if the farm yard manure supplies over two-thirds of the required nitrogen, the yield is less than when more cake is applied.

(B) *Continuation of water experiments.*—The results up to the present fix about 350,000 cubic feet of water as the amount required in the Deccan soil to produce the heaviest crop and the interval of 8 days in hot weather and 10 in cold is the best.

(C) Experiments to investigate factors which affect the quality of gul.

The work of the first year was of a preliminary character. In 1910-11 the work was not taken up, but it has been taken in hand again in the current year.

The system of gul-making has now been thoroughly studied and we have succeeded in getting a standard method of boiling. We have also fixed standards for judging the qualities of gul, as colour, hardness, taste, etc.

The effects of different systems of manuring, different sorts of soils, different seasons of planting and ripeness, etc., will be observed.

Cotton.

The cottons of Sholapur and Ahmednagar are being analysed and the various types found, grown separately to see which is the most profitable. Alongside of these types certain allied varieties from Central Provinces are being tried.

The value of sulphate of ammonia, sulphate of potash, and mineral phosphates alone and in combination is being studied.

Ground-nut.

The question of the extension of the area of ground-nut is being much investigated with regard to finding in which region the smaller and quick growing varieties like small Japan and Spanish will be profitable.

Some experiments to ascertain what manures would be useful to ground-nut are in hand.

Tobacco.

The question of top-dressing tobacco with sulphate of ammonia is being investigated.

Moisture Conservation (Dry Farming).

Experiments in finding the best way to conserve soil moisture are in hand at two centres. Better ploughing, more frequent intertillage and lower seed-rate have so far shown most promising results.

Rab.

The rab work on a large scale is given up for the present and the results will soon be worked up.

III.—ECONOMIC BOTANY.

(W. BURNS, B.SC.)

1. The description, classification, and selection of important local fruit crops will be continued. Study will be made of the soil, water, and manurial requirements of these crops, and of the best methods of pruning, packing, grafting, etc., in connection with them. The work will be divided among the staff. The Economic Botanist will personally study grapes and mangoes; assistants will deal specially with pomegranates, guavas, papayas, citrus varieties, and plantains.

2. The following diseases are being investigated :—

(1) *Grape vine mildew.*—The Economic Botanist will conduct spraying experiments with Bordeaux mixture on a large scale. The botany and pathology of the mildew fungi will be studied by the Assistant Professor of Mycology.

(2) Castor rust and

(3) a disease of papaya fruits will be studied by the Assistant Professor of Mycology.

(4) The botany of a new Uredine (*Cystopora Oleæ,*) will be studied by the Assistant Professor of Mycology.

(5) The smuts of *bajri* and *jowar* will be investigated by the Assistant Mycologist, who will also be engaged in propagating the knowledge and practice of seed-steeping.

(6) The Assistant Mycologist will complete the survey of the distribution of red-rot of sugarcane (*Colletotrichum falactum*) in the Bombay Presidency. He will supervise the distribution of good seed from specially planted plots in infected areas, and study the effect of growing good seed in infected soil.

(7) The leaf-car disease of *jowar* and *bajri* (*Sclerospora graminicola*) will be studied by the Assistant Mycologist.

(8) A disease of orange trees resembling that called " blight " in America will be studied by the Economic Botanist and one of his assistants.

(9) Tikka disease of ground-nut and

(10) Wilt disease of tur will be observed as opportunity occurs.

(11) Wheats will be bred in pure lines as a preparation for testing their rust-resisting qualities.

3. The collection and multiplication of seed of likely wild fodder plants will be taken in hand. Study will be made of the composition of green and dry fodders from various parts of the Presidency.

4. Search will be made for wild plants likely to be useful as green manure, seed collected, and trials given to these.

5. The collection and trial of wild thorny plants as hedges will be continued.

6. The classification and description of rices of the Presidency will be proceeded with.

IV.—AGRICULTURAL CHEMISTRY.

(HAROLD H. MANN, D.SC.)

The following subjects are already under investigation :—

1. *The rab system of rice culture in Western India.*—Considerable progress has been made in the investigation of this subject, the results of which have been embodied in a memoir now in the Press. There is, therefore, no further need to recapitulate them. The investigation will be continued on similar lines to those already initiated. As a side issue of this investigation, the effect of various substances in removing the sticky, viscious character from soils is under examination, and a memoir on this subject is almost ready for publication.

The object of this work is, finally, to devise a substitute for the present very wasteful *rab* system,—and in the alternative, to find a more economical method of carrying out the *rab* process.

2. *The salt lands of the irrigation areas of the Bombay Presidency.*—These salt lands have been considerably increasing in recent years, and it has become vital, with the very large extension of irrigation canals in our black soil areas, to ascertain how far the development of salt land and barrenness can be prevented. A report on the subject, so far as the Nira Valley Canal area is concerned, has already been published as a Bulletin of the Bombay Department of Agriculture. Drainage, properly arranged, seems to deal with the evil, but the arrangement of the drains seems to be the vital matter in black cotton soil.

3. *The milk of Indian cows and buffaloes.*—One memoir has already been published on this subject, in co-operation with Mr. Meggitt, and another is almost ready for Press. These, however, only open the subject,—and the existence of a large civil dairy in Poona gives excellent facilities for extending the work.

4. *The nature, properties, and more wide utilisation of safflower oil.*—Safflower is one of the principal dry land crops, in the driest areas of the Deccan. The oil is capable of much wider utilisation than it has hitherto had, as it is one of the best of the drying oils—though, of conrse, far below linseed.

5. *The constituents of betel-vine leaf and their variations.*—This has been undertaken with a view to improving one of the most valuable and profitable of the garden crops.

6. *The composition of well waters in the trap areas, in use for irrigation and their variation.*—The whole question of well waters, and their composition, is of great importance in the trap areas, where much of the soil is continually spoilt by the use of unsuitable waters for irrigation.

The investigation of these subjects will be continued, and it is not anticipated that time will allow the commencing of much other work.

V.—DEPUTY DIRECTOR, SIND.

(GUL MAHOMED ABDUR RAHMAN).

The programme may be divided into five sub-heads as under :—

1. Experimental Work.
2. Practical District Work.
3. Inauguration of the Agricultural Education.
4. Reclamation of Alkali Lands.
5. Miscellaneous.

Experimental Work.

There are two experimental farms in working order and a third for Larkana District has been sanctioned and will be started during the current year.

The experimental work will consist of—

(*a*) Continuation of crop rotation system with special application to perennial irrigation.

(*b*) Extended trials of long stapled cottons such as Egyptian and American and other Indian varieties.

Egyptian cotton could not, unfortunately, be given an extended and fair trial in the past owing to the failure of the Jamrao Canal.

Cultivation of American cotton is extending rapidly and a large quantity of seed was distributed last year and a considerable area will be sown next year.

(*c*) Trial on larger scale of leading varieties of cereals, pulses, fibre, and leguminous crops from outside the province.

(d) Introduction of superior Lower Sind and exotic cottons to replace the short stapled, growing in Upper Sind. It will be interesting to note that the cotton cultivation which was practically *nil* in Sukkur District is, owing to its successful growth on the experimental farm, gradually but steadily making its way.

(e) To solve the problem of irrigation requirements for rice and other dry crops.

(f) Cultural, manurial, and varietal experiments with wheats.

(g) Cultivation of berseem on an extended scale as a best fodder and rotation crop.

(h) Adoption of insect preventive methods both in orchard and cultivated crops.

Practical District Work.

The nine sub-stations with a seed store attached to each group, designed to serve, the agriculturally backward tracts with regard to superior methods of cultivation and growing of new and better crops, will be continued with an addition of two or three more.

This probably is the best plan of bringing home to cultivators the successful, work of the Department, and the itinerant instructors are fully and usefully employed in holding demonstrations, distributing seeds and implements, and solving the difficulties of land-holding classes.

Agricultural shows and exhibitions are getting popular and will be held on an extended scale.

As a result of successful demonstrations and shows, over 500 ploughs introduced by the Department have been disposed of during the current year and in some places the primitive Sindhi ploughs have been entirely replaced by improved ones.

Inauguration of the Agricultural Education.

An agricultural school has been sanctioned and will shortly commence its work with a view to diffusing agricultural knowledge among the cultivating classes and thereby enabling them to improve their lands in general and incidently to train hands for recruitment in the Department. The effect of this education is bound to be marvellous.

Reclamation of Kalar Lands.

Reclamation of 400 acres of the worst Kalar at Daulatpur has been successfully carried through and it is proposed to wind up the whole concern immediately after the Rabi crop (berseem) is harvested.

Miscellaneous.

Besides the work detailed above, the Department has been endeavouring to encourage poultry-breeding and rearing with a view to obtaining better strain both for laying purposes and for table. Experiments are being carried out on the above lines with Bushire and selected country breeds.

The concern is finding favour with zemindars.

Horticulture is also one of the subjects receiving attention and the Department is getting a large number of orders from zemindars for cuttings and seedlings of various fruit trees and vegetable seeds newly introduced in Sind.

5.—MADRAS.

I.—DEPUTY DIRECTOR, NORTHERN DIVISION.

(G. R. Hilson, B.Sc.)

Agricultural Stations.

I.—Bellary.

Proposals will be put up for the abandonment of this farm, and if these are sanctioned, the buildings alone will be retained; if not, the farm will be utilised for sowing out on a larger scale improved types evolved at Hagari of the local crops.

II.—Hagari.

Black cotton soil area.—Selection work among the crops locally cultivated, *viz.*, cotton, sorghum, sazza (*Pennisetum typhoideum*), korra (*Setaria italica*) will be continued. This has resulted, so far, in the production of two improved types of indigenous cotton and arrangements are being made for their growth on a large scale, partly on the farm itself and partly on outside land by agreement with the owners.

The manurial experiments to test the effect of sheep penning regularly each year, and of an annual application of magnesium sulphate, will be continued, as also will be the investigation of the reason for a succession of *korra* crops resulting in a decreasing yield.

The garden.—This has now been laid out. The objects aimed at here are the investigation of methods of cultivation of garden crops grown locally, *viz.*, ragi, tobacco, chillies, onions, sugarcane, irrigated sorghum, in order to introduce possible improvements and also the introduction of paying crops such as Cambodia cotton and ground-nut in order to induce the ryot of this district to pay more attention to garden cultivation and thus safeguard himself against famine.

III.—Nandyal.

Selection work in cotton and sorghum will be continued. Three types of the former have been obtained and are being sown out on a field scale to test their yielding qualities.

Proposals have been put up for the extension of this farm, and if these are sanctioned, the land will be got into order for experimental purposes.

Manurial experiments laid down this year to test the effect of sheep penning as compared with an application of farm yard manure will be continued. The cultural experiment to test the effect of sowing cotton mixed with horse-gram will be continued.

IV.—Bezwada.

Proposals have been submitted for the closing of this farm; if these are not sanctioned, the farm will continue to be utilised for the production of seed of Cambodia cotton, exotic maizes, and *sazza* for distribution.

V.—Samalkotta.

Sugarcane.—The testing of the new varieties of sugarcane and of variations from the local methods of cultivation will be continued. The manurial experiments show that farm yard manure is a poor manure for sugarcane and that the application of chemical manures along with castor cake does not make any appreciable difference. These experiments will therefore be altered and the effects of applications of different kinds and quantities of oil-cakes tested.

The rotation of sugarcane with dry or semi-dry crops will be given up.

Paddy.—The cultivation experiments to test the optimum seed rate and spacing for paddy, and which have so far shown that very close planting for "doubles" results in a poorer yield and that a seed rate of 200 Madras measures per acre is too heavy, will be continued.

The manurial experiments will be continued.

Selection work and the testing of new varieties will be continued both on a larger scale. The water experiment will be continued.

Dry crops.—The cultivation experiment with turmeric will be continued. Selection work in dry paddy and red gram will be continued and maize will be grown for distribution.

VI.—Anakapalle.

Proposals have been submitted and a site chosen for a new farm in Vizagapatam District. If these are sanctioned, the work of laying out the farm and putting up buildings will be begun.

VII.—District Work.

(*a*) The experimental and demonstration plots in connection with *pati-mannu* work will be continued.

(*b*) Demonstration of deep ploughing in Kurnool and Kistna Districts will be continued.

(*c*) Distribution of improved varieties of sugarcane will be continued.

(*d*) Introduction of ground-nut into Vizagapatam and Ganjam will be continued.

(*e*) Demonstration in all paddy-growing tracts of the success of single transplanting paddy seedlings after suitable treatment in the seed bed. The demonstration plot under Nandyal tank will be retained.

(*f*) Distribution of Nandyal cotton-seed in Kurnool District will be continued, the number of seed farms being increased.

(*g*) Distribution of Hagari cotton-seed in Bellary District will be begun and a seed farm will be started.

(*h* The use of a 1 per cent. solution of copper sulphate as a steep for sorghum will be advocated.

(*i*) The planting of sugarcane in rows and paying greater attention to drainage will continue to be advocated.

(*j*) Green manuring for wet land crops will be advocated.

II.—DEPUTY DIRECTOR, SOUTHERN DIVISION.

(H. Southern, B.A.)

Koilpatti Agricultural Station.

(1) *Indigenous cotton.*—The work of selection will be continued. A very favourable report has been received from the Imperial Cotton Specialist on some of last year's selections, and, as the crops grown this year from those selections have also given good results, it is intended, this coming season, to sow their seed on a farm crop scale. Owing to natural *inter se* fertilisation of cottons, it has been found to be very difficult to fix types; it therefore seems probable that periodical selection will be necessary to maintain the quality of lint.

(2) *Spacing experiments* will be continued, the results at present being inconclusive.

(3) *Deep and shallow ploughing.*—This experiment has been worked in conjunction with the rotation experiment; this year however that part of the field which has been getting shallow cultivation only has become so foul with *Hariali* grass that the experiment has had to be given up. Thus the results are all in favour of deeper cultivation.

(4) *Mixed cropping trials*, both with cumbu and cotton sown with the drill, will this year be made, the object being to test the yields of the main crop as affected by the mixture.

(5) *Cumbu (Pennisetum typhoideum).*—As none of the introduced varieties under trial show any marked superiority to the local variety, more attention will, in future, be given to the improvement of the latter. Local cumbu seed will therefore this year be sown with a view to getting a crop for selection purposes.

(6) *Cholam.*—Previous attempts to grow cholam for grain in this tract have always failed. However, a variety from Coimbatore black soil was introduced last year which set grain, but owing to the prolonged drought the grain never filled. This variety will again be tried this year.

(7) *The manurial experiments* will be continued on the same lines.

Koilpatti red soil block.—The work on this portion of the farm will be continued on similar lines to those laid down last year except that the experiment of green manuring garden crops will be tried.

Palur Agricultural Station.

(1) *Ground-nuts.*—The variety experiments will be continued. At present, however, none of the exotic varieties have yielded as well as the local Mauritius variety. A trial was last year made with seed of local Mauritius groundnuts obtained from different parts of the Presidency, and it was found that the imported seed yielded better than the local seed. This trial is being continued this year with seed saved from last year's crops.

(2) *Rotation experiments on dry land.*—The cereal ground-nut experiments will be continued in order to test the value of the rotation, *viz.*, a cereal followed by ground-nut in one year with the same rotation spread over two years. The results already obtained, which however require confirmation, seem to show that the mixed cropping is more profitable, also that a change in the cereal gives better results than the same cereal each year.

(3) An experiment is in progress to find a suitable crop to rotate with irrigated ground-nuts, and, of the several crops under trial, Cambodia cotton has been found to be the most suitable. This year's ground-nut crop on land, which was last year under Cambodia cotton, has given a better yield than crops on similar land which has been under ground-nuts for several years. Other exotic cottons, including Sea Island, American Upland, and Bourbon, which have also been tried on irrigated ground-nut land, have not given such good results. Their failure, however, may be due to the fact that they were not sown at the right time; this year some plots will be sown before and others after the heavy rains of the north-east monsoon.

(4) *Cereal.*—The experiments dealing with the cultivation of new varieties of dry land cereals will be continued.

(5) *Sugarcane.*—The variety test will be continued. One or two of the newly introduced varieties give promise of being very useful in this district where the area under canes is increasing.

(6) *Paddy.*—*The manurial experiments* will be continued. So far the results go to show that a bulky manure, when applied to a field which has been manured with cake in the previous year, gives very good results.

(7) *Green manures.*—Sann hemp (*Crotalaria juncea*) and Dhaincha (*Sesbania aculeata*) have proved themselves to be the most successful of the various green manuring crops which have been under trial. The practice of green manuring wet lands is spreading, and, to meet the demand for Dhaincha seed, it has been found necessary this year to rent 30 acres of land near Palur for the purpose of growing a Dhaincha crop for seed.

(8) *Spacing experiments.*—There is no need to continue this experiment further as it has now been definitely shown that economic planting pays. The entire paddy land, therefore, has this year been planted with single seedlings. In place of this, a new experiment will be commenced in order to find out how far it is profitable (*i*) to supplement a green manure crop with an artificial fertiliser on single crop lands ; (*ii*) to supplement the residual manurial value of a green manure crop with an artificial fertiliser on double crop lands after the first crop has been harvested.

(9) *The variety tests* will be continued.

Taliparamba Agricultural Station.

(1) The study of the pepper crop will be continued on the lines originally laid down.

(2) *Paddy.*—The spacing experiments have been given up this year and the whole area has been planted with single seedlings. Trials of various green manuring crops will be continued. Cow-gram, a quick growing crop, which can be sown with the April-May showers at the same time as the paddy nurseries, and is ready to be ploughed in when the monsoon breaks in June, has at present given the most successful results.

(3) *Sugarcane.*—Variety experiments will be continued. A larger area has this year been planted with Barbadoes No. 208 canes, as there is a large demand for this variety, which will probably supersede Red Mauritius on the West Coast on account of its short sturdy habit, which does away with the necessity of using props to support the canes. The cultivation of sugarcane is now spreading rapidly and there seems to be a great future for this crop on the West Coast. Iron mills, boiling pans, etc., are being purchased by Agricultural Associations as well as by private individuals.

(4) *Dry land cultivation.*—The object of this portion of the farm has been to a great extent accomplished. It was desired to show to the ryot that the more level portions of the laterite hill soils, which are usually under fugitive cultivation, can be permanently cultivated, with profit, if a suitable rotation is adopted. Very profitable crops of ginger, chillies, ground-nuts, and hill paddy have been obtained, and many ryots in the neighbourhood have now taken up this method of cultivation. This work will be continued on the same lines.

Work outside the Agricultural Stations.

(1) *Cotton improvement.*—The area under seed farms in the Tinnevelly District will this year be further reduced to 400 acres, as results have shown that, when good seed has once been introduced, ryots will take care to get seed for themselves from their crops. Owing to this it will be possible to devote more time to the spread of drill cultivation and deep ploughing. The work will otherwise be continued on the same lines as last year.

(2) The work in connection with the introduction of green manuring crops and the improvement in paddy cultivation will be continued this year on the same lines in the Cauvery Delta. In this neighbourhood several Archimedian screw water lifts have recently been sold in localities where the baling basket or wooden scoop is generally in use. Though no satisfactory trial has yet been made with these lifts, it is believed that they can do double the work of a picottah.

(3) Work of a similar nature has this year been begun in the Periyar tract, where there is a great scarcity of green leaves.

(4) On the West Coast the extension of sugarcane cultivation and permanent cultivation of dry lands will be continued. In the Wynaad, where the demand for green leaves for ginger cultivation is so great that the paddy crop is apt to be neglected, an effort will be made to introduce the practice of green manuring paddy lands with cow-gram.

(5) As Cambodia cotton is now spreading so rapidly of its own accord, it will be unnecessary this year to devote much time to this work.

(6) Wherever possible demonstrations of implements will be made. The demand for iron ploughs in the Tanjore District and for such implements as the harrow and Sind plough in South Arcot still continues.

(7) In Salem and North Arcot Districts the work will be continued on the same lines as last year.

III.—AGRICULTURE.

(R. W. B. C. Wood, B.A.)

1. *Educational work at the College.*—The usual routine will be continued : as this has not before been presented to the Board, the following summary may be given. The Principal is responsible for the whole of the teaching in Agriculture, Theoretical and Practical, Veterinary Science, and Agricultural Engineering, with the assistance of a staff of four, two of whom teach the two last-mentioned subjects, while of the other two, the Chief Assistant supervises the work of the first and second year classes (eighteen hours a week field work), and corrects their observation note books, while the last man supervises the work of the third year. The Principal also takes the third year students for two district tours each year, which are not only of great educational advantage to them, but serve to keep him in touch with district conditions and work. The lectures delivered by him have not yet reached a state of finality and will need a good deal of revision during the coming year. It is hoped to prepare a small Agricultural Note Book during the year on the lines of McConnell's Agricultural Note Book, suited to South Indian conditions. The Museum will, it is hoped, be fitted up shortly, and the work of acquiring and preparing specimens will be attended to.

2. *Farm management.*—The area under crop at the Central Farm is near / 400 acres, much of it carrying two crops a year. It is managed by the Principal who is assisted by a Farm Manager and three Assistant Farm Managers and contains, besides numerous experiments, plots cultivated by and for the students. Time will not permit of very extensive or careful experimental work, but the following lines may be briefly noted :—

(*a*) *Seed selection.*—This at present has been most successful in the case of paddy (*Oryza sativa*) : but in this and other crops the assistants do not yet possess sufficient aptitude for the work, and little real progress may be expected until the time can be found for closer personal supervision. Attention will be paid to this during the coming year.

(*b*) *Manurial experiments.*—With paddy (*Oryza sativa*), these have shown the need for phosphatic manuring and in consequence large quantities of this will be used for this crop. Equivalent quantities of nitrogen in different forms will be applied to sugarcane and ragi (*Eleusine coracana*) to compare the permanence of their effect. The permanent manurial plots will be maintained : the results are just beginning to be visible.

(c) *Dairy work.*—The lines on which this will be run are not yet settled and a good deal of preliminary experiment will have to be made. The Principal hopes to take a course of dairy work when on study leave during the coming year.

(d) *Cultural experiments.*—These will be arranged to try the effect of a green manure crop both on wet and on irrigated lands. The latter is a new departure and is promising. The country plough is still the most generally useful implement, but a ridging plough has been found successful. Transplanting experiments have shown that wider planting of well developed plants is better in the case of paddy, and the system will be generally adopted on the farm. The best spacing will, however, remain an object of experiment. The ridge and furrow system of growing irrigated crops has passed the experimental stage and will be generally adopted on the farm.

(e) *Miscellaneous.*—A trial of a power-driven disintegrator will be held during the year for the purpose of making bonemeal on a small scale. There are many ryots who now own oil-engines for which the work of lifting water does not find sufficient occupation, and they could possibly find in the manufacture of bonemeal a remunerative way of keeping the engine at work.

IV.—ECONOMIC BOTANY.

(C. A. BARBER, M.A., F.L.S., D.Sc.)

1. The Government Botanist will deliver a course in Agricultural Botany, the elementary teaching being relegated to an assistant.

2. He will have general control of the Botanical Assistants and will devote special attention to the preparation of the herbarium collections for forwardal to Mr Gamble at Kew. It is proposed to write a Flora of Madras and the natural orders will be sent over in succession as required by Mr. Gamble.

3. The Government Botanist has the general control of the Entomological Assistants, although it is hoped that this work will early be taken over by the newly-appointed Entomologist. The work will chiefly consist in the continuation of the investigation of the South Indian crop pests in the various districts. There will also probably be a continuation in the campaign against the Deccan grasshopper on which one assistant is at present engaged. The work recently started in eri-culture will also be continued, and, besides forming a centre for information on this subject, an attempt will be made to determine if this industry can be profitably introduced into South India.

4. The upkeep and extension of the botanic garden and the general care of the trees and shrubs planted out on the College estate.

5. If time permits the Government Botanist proposes to devote some attention to the study of seeds with the idea of evolving some method by which bazaar seed can be quickly sorted in order to purify the crop of undesirable forms.

V.—AGRICULTURAL CHEMISTRY.

(W. H. HARRISON, M. Sc.)

1. The number of samples received from persons outside the Department is rapidly increasing, and as this constitutes one of the means by which the interests of the cultivators in the Department is aroused, such work will be encouraged as much as possible, especially as an increase in the staff has recently been sanctioned.

2. The lectures in Physics will, in future, be given by a member of the Agricultural Chemist's staff, and it is proposed to substitute a series of lectures on Agricultural Bacteriology in place of the present series on Soil Physics, as the latter are given in another series of lectures and overlapping ensues.

3. Work in connection with research and investigations has been considerably hampered by the fact that no assistance was available to relieve the Agricultural Chemist of the more preparatory and mechanical portions. The sanctioned increase of staff will now permit of this being done and also work in connection with the pot-culture house.

4. During the past two years constant analyses have been made of the gases given off from paddy soils, and considerable changes in composition and their relationship to the period of cultivation have been made apparent. Consequently attention will now be mainly directed to elucidate the effect, if any, of the crop on the composition of the gas.

In addition to the above, paddy soil has been examined bacteriologically and several specific organisms have been isolated which bring about the decompositions of particular types of organic matter. Work on these lines will be continued, but the greatest attention will be paid to those fermentations leading to loss of nitrogen.

5. A general soil survey has been made of the more accessible portions of the Kistna Delta with the result that the portion irrigated from the Godavari has a different composition to that irrigated by the Kistna, and a different system of manuring will probably be adopted in each case. This survey will be extended to the central portion of the Delta and in addition a similar soil survey will be commenced in the Tanjore Delta.

6. In conjunction with the Deputy Director of Agriculture, Northern Division, an investigation was carried out in the Kistna Delta, its object being to induce the ryots to utilize indigenous manures in place of *potti-mannu* (manurial earth) which is now very scarce. By means of experimental and demonstration plots, and the free distribution of manure, the object aimed at appears to have been attained, as a firm of manure manufacturers have now started depôts for the supply of manure. It does not appear probable that the Department can do much more in this direction, but the experimental plots will be maintained for several years, as the results obtained are likely to throw considerable light upon the nutrition of paddy under swamp conditions.

7. A large number of samples of black cotton soil from various parts of the Presidency have been examined for their manurial constituents and a connection between their mineral composition and the underlying strata has in most cases been established. As this work will probably lead to a knowledge of the formation of such soils it will be continued.

8. The silts of the Kistna have been fully examined and reported upon. If other work permits, the silts of the Cauvery will be examined.

9. The pot-culture house is now completed, and it is proposed, in the first instance, to study the effect of magnesium manures on certain types of black cotton soil. The evidence obtained from some small field experiments goes to show that under certain conditions the yield from the crops is materially affected. Apart from the above, problems connected with the manuring and nutrition of paddy will be studied.

10. The composition of South Indian crops, chiefly from the point of view of their mineral constituents, will, if possible, also be studied.

VI.—MYCOLOGY.

(W. McRae, M. A., B.Sc.)

1. *Research and experimental work.*—The work on the investigation of the smuts of cholam (*Sorghum vulgare*) will be continued and those of cumbu (*Pennisetum typhoideum*) taken up.

The investigation of the life history of sugarcane and paddy smuts will be begun.

Assistance will be given in connection with the campaign against the bud rot of palms in the Godavari and Kistna Districts. The whole of the affected area is now under operation. The number of dead palms cut in the former district is gradually becoming smaller. The latter district has not been long enough under operation to show a definite substantial decrease.

The investigation of the application of preventatives against the koleroga disease of areca-nut palms in South Canara and South Malabar will be undertaken.

The collection and identification of parasitic fungi in Madras has been begun.

2. *Training.*—A short course on the principal crop diseases of the Presidency will be given to the students of the college, and the training of the staff will be continued.

6.—CENTRAL PROVINCES AND BERAR.

(C. E. Low, C.I.E., I.C.S., Director of Agriculture.)

Agricultural Stations.

The four agricultural stations will be as in preceding years. A temporary demonstration and experimental station is to be started in the area commanded by the Ramtek tank: and another on a larger and more permanent scale in the centre of the irrigable area in Chanda. Implement depôts of the type already existing in Nagpur and Hoshangabad have been started on a small scale at Akola and Raipur also. A beginning has been made in handing over the work of these depôts to private enterprise. The bull-breeding farms at Hoshangabad and Nagpur will remain as before: but at Nagpur a more rigid casting of stock will be introduced in order that only the best animal may be issued for breeding purposes, even though the type selected and maintained does not possess in a marked degree all the fanciful characteristics that appeal to the native breeder or *goalas*.

In the Northern Circle small plots of land will be taken up in the following districts for the following reasons:—

Jubbulpore.—A small plot under a Government irrigation work, on which can be demonstrated, after experiment the most economical use of irrigation in the crops and soils of the Jubbulpore District. Conditions of this tract differ widely from those pertaining to the Hoshangabad Farm: and for a year or two the work here will be largely experimental. When the work gets to the demonstration stage, this farm will he stopped, and a regular demonstration programme started to cover the whole tract. The farm at Mahgwan in Jubbulpore District will be continued, for, further experiment in the better cultivation of rice and irrigation of rabi is needed before any demonstration can be attempted. This farm is of small extent and is only temporary. A suitably equipped experimental farm will shortly be opened on a convenient site near Jubbulpore.

Damoh.—A similar farm temporarily opened at Damoh will be closed down because the necessary staff cannot be spared at present. The main object with which it was started, however, namely, the demonstration of the complete eradication of "kans" by deep ploughing and flooding, has already been achieved, and the land has been cropped this year and has borne a good wheat crop.

Nimar.—A similar small plot, for the growth of cotton. This will be more demonstrative from the outset; but it cannot be wholly regarded as a demonstration, for the rainfall and soils are very different from those found at Akola and Nagpur. With the advice of Messrs. Clouston and Gammie, it is hoped that Mr. Evans will be able to demonstrate the possibility of growing better varieties of cotton.

The experiments in cotton varieties at Khandwa last year led to hopeful results, but the experiments will be continued next year with a few varieties which show special promise.

These three temporary farms are really demonstrations: but some experience must be gained; and by the time that knowledge has been attained fully, the staff should be available for the institution of a demonstration programme on a large scale.

The principal experimental work is given below:—

Cotton.—The chief experiments in cotton will be carried on by Mr. Clouston at the Akola Farm in consultation with Mr. Gammie. Plant-to-plant selection will be in its sixth year, the object being to increase the yield of *buri* and of indigenous varieties; to get a higher percentage of lint to seed in all varieties; and to improve the fibre of *buri* and *malvensis*. Selected varieties will cover 175 acres at this farm. Hybridizing will be continued, but will be confined to the crossing of *bani* with the *jari* types.

This work of selection will also be carried on at Telinkheri and at Nagpur, in co-operation with Mr. Allan on the latter farm.

The experimental series dealing with rotation, tillage, spacing, manure, and topping will be continued. The advantage of sowing cotton before the break of the rains, the value of *bhendi* as a trap crop for bollworm, and the advantage of growing peas, gram, and other leguminous crops as soil renovators between rows of cotton will be tested.

Wheat.—The experimental series detailed in the last programme will be continued at Hoshangabad under Mr. Evans, Deputy Director of Agriculture. Another experiment of importance that has been started is the double-cropping of embanked land on typical heavy soils: a catch crop of rice followed by valuable rabi staples in embanked lands is found on large areas in both the north and south of the provinces; and it has generally been reported that this practice has not extended to the Hoshangabad wheat tracts, because the soil does not embank well: this will now he tested. The experiment in wheat from the standpoints of rust and drought resistance, quality and yield are of great importance. The non-experimental area of this farm will be practically devoted to propagation of select seed for distribution. The effect of irrigation in changing the character of wheat will again be watched.

Rice.—The experimental series in connection with rice at Raipur will not be altered. Mr. Graham will be able to hand over to Mr. Clouston for further trial several new varieties, selected after classification. Plant-to-plant selection of approved varieties will be continued. On the small area available for rice at Telinkheri selected varieties will be grown for distribution. An experiment to test the value of wild lucerne (*Melilotus alba*) both as a fodder crop and as a soil renovator for land which grows rice continuously without manure may be of great help in solving the manure and fodder questions for Chhattisgarh.

Miscellaneous crops.—Plant-to-plant selection of cane will be continued at Raipur. The existence of large Government irrigation works and the prospect of the early completion of even larger ones has greatly increased the relative importance of this crop, rendering it necessary to start cultural experimental series, and to modify the present varietal and manurial series. Different varieties of ground-nuts will be further tested at Raipur, Akola, and Hoshangabad; and selection of tur will be continued in order to improve outturn and find a wilt-resistant variety. The trial of local grasses on the Akola Farm is giving good results: a leguminous weed (*Alysicarpus rugosus*) will be added to all the plots in the ensuing year to improve their pastural value.

Manurial experiments.—There is some possibility that sulphate of ammonia may become available in large quantities at Nagpur, in the near future : the continuous series that contain this will therefore be of particular interest. Bonemeal has proved a good and profitable manure for rice in Chhattisgarh. Steps will be taken to manufacture it in this Division and to popularise its use among rice-growers ; also to popularise the use of cake as a top dressing for sugarcane, and of sann hemp as a green manure for rice.

Agricultural education.—It is trusted that work will be started on the College laboratories in the near future. During the current year the hostel has been improved considerably and the Principal, Mr. Allan, personally conducts the direct agricultural teaching of the various years. On the farm adjoining the College, some cattle-feeding experiments will be started.

Agricultural Chemist and Economic Botanist.—Messrs. Plymen and Graham will continue to work in conjunction with officers in charge of farms : in the selection of cane and wheat Mr. Plymen's work has already been of great use. In conjunction with Mr. Allan, Mr. Plymen will study the moisture-contents of black cotton soil under different systems of cropping and cultivation : he will also examine the effects of some of the well waters used for irrigation, and assist Mr. Evans in the enquiry about the comparative suitability of the Nerbudda Division soils for embanking.

Classification of the *juars*, sann hemp, *bajra*, *Capsicums*, and rices will be the chief work of Mr. Graham. The collection of economic plants will be amplified : it will be extended round the new laboratories when that land is available.

Whenever possible, these two officers will tour in the various tracts of the provinces.

Demonstration.—The work under this head is increasing. An area of about 4,000 acres has been under the supervision of Mr. Clouston in Chhattisgarh, the work being transplantation of rice, irrigation of wheat, and cultivation of cane and ground-nut. Similar work, with the addition of jute occasionally, will be undertaken in the Nagpur Division under the Ramtek reservoir and in the cane growing tract of Chanda. In order to ensure complete supervision it may prove impossible to increase the area in Chhattisgarh, for every year more centres are made available for this work by the Irrigation Department in other districts : and if a maximum of 4,000 or 5,000 acres in one Division is maintained, with the ground constantly and gradually changing, a complete reformation of the existing condition will soon be obtained. The improvement of agricultural practice in irrigable areas in order to enable the people to avail themselves fully of the improved water-supply, is recognised as the most important feature of departmental work on grounds of administrative necessity. To further this work, a class for actual tenants or their sons or ploughmen has been started at Raipur : this is really part of the demonstration scheme, for the courses are but of a few weeks only, and embrace the improvements that are carried out in the demonstration centres. The "Kamdars" will gradually increase in number, as men become trained on the farm. As it has been felt that demonstration work, especially in the rice tract, is greatly handicapped by the employment of agricultural assistants who are physically weak and who are unused by hereditary connection and by their upbringing to agricultural work before starting their college course, steps are being taken to attract recruits for the Department from the best agricultural castes. The training and the use of "Kamdars" will be still further extended both at Raipur and Hoshangabad, and short practical courses in special local crops will be given also to cultivators and Court of Wards subordinates.

The cotton-seed farms have been, and will be further, amplified into demonstration centres. There are 42 existing seed farms ; the number will be increased. Cotton-seed farms will, if possible, be opened in Nimar and Harda. Assistants in charge of these farms in the current year have also supervised cultivation of *buri* cotton on nearly 600 acres, and with the amount of selected seed now available of this variety it is expected that 3,000 acres in Berar alone will be under demonstration next year. This new variety is specially recommended for wilt infested lands.

The use of copper sulphate, improved machinery, and conservation of manure are also taught in these demonstration circles.

In the Northern Circle three centres have already been mentioned. In the current year several wheat-seed farms have been started under the supervision of assistants : these will be increased in number as rapidly as possible compatible with supervision, for the high seed rate of wheat makes the multiplication of these centres most necessary. Satisfactory arrangements have been made to ensure that the produce of existing farms will be reserved for distribution: there is now a brisk demand for this selected seed. Demonstration in the Kanthar tract of Jubbulpore District in the better cultivation of cotton and *juar* proved successful last year on a small scale. An agricultural assistant with five "Kamdars" under his supervision will open demonstration plots in a large number of villages in this tract next season.

Demonstration of implements will be made at all the chief fairs and elsewhere. In the Northern Circle the conservation of seed potatoes will be further encouraged by demonstration: in the current year that has been most successful. At the Raipur Farm a small vegetable garden has been started, and it is trusted that this will be imitated in the Chhattisgarh Division.

Seed farms for the propagation of pure wheats have been opened at various centres in Narsinghpur, Jubbulpore, Seoni, and Damoh Districts. The seed farms are managed by selected members of the local Agricultural Associations and in the majority of cases promising results are being obtained. Each farm is inspected at least once during the season and the number of fresh seed farms will necessarily be limited by the trained supervising staff available.

The introduction of an improved variety of *Maghai til* is being continued in Narsinghpur and Hoshangabad, and in spite of last year's unfavourable season, there is every reason to hope that the introduction will be speedily effected.

Last year two hundred acres of this new variety were sown, but owing to unfavourable rains about half of this year's crop had to be ploughed up. Next year a very large increase in area can be expected.

Agricultural Associations.—All meetings will be attended by officers of the Department and the associations further exploited as a means both of diffusing and gaining knowledge. Divisional meetings will be held on the experimental farms and *sanads* will be presented to members who have done good work for advancement of agriculture.

An experiment has been made in the opening of sub-associations in Hoshangabad and Jubbulpore, the members of which are cultivators only. Each sub-association has a simple and definite programme laid down and each member promises to carry out the programme to the best of his means.

A divisional meeting is held on the Hoshangabad Farm once a year where *sanads* are given and criticisms of new implements, seeds, etc., are invited and general discussions take place.

Publications.—*The Agricultural Gazette* will be published monthly ; bulletins and leaflets also will be issued. Arrangements have been made for the issue of leaflets with selected seed of varieties not commonly known.

7.—EASTERN BENGAL AND ASSAM.

I.—DEPARTMENT OF AGRICULTURE.

(S. G. HART, I.C.S., DIRECTOR OF AGRICULTURE.)

As a general review of the work in progress a memorandum by His Honour Sir Lancelot Hare, K.C.S.I., C.I.E., is republished :—

"Memorandum dated the 17th August 1911, by Sir Lancelot Hare, K.C.S.I., C.I.E., Lieutenant-Governor of Eastern Bengal and Assam, on the work of the Agricultural Department during the past five years, and programme of future work.

On the 16th February 1906 Sir Bampfylde Fuller recorded a memorandum on the programme of the Agricultural Department of Eastern Bengal and Assam as settled in conference with the Inspector-General of Agriculture. Five years have elapsed since then and Sir Lancelot Hare feels that the time has come to review the progress made and to consider the most advantageous lines for development in the near future.

The staff and preliminary work.

2. The superior cadre of the Department now comprises the Director, two Deputy Directors, a Chemist, Botanist, Fibre Expert, and Arboricultural Expert, each with a staff of assistants. The Chemist, Botanist, and Fibre Expert have their head-quarters at the laboratory on the Dacca Agricultural Station. The laboratory was opened for work in May 1910; its design, construction and fittings are excellent, and probably no building more suitable for scientific research work is to be found in India. The capital cost of the laboratory, including fittings, and gas and water installations, exceeds one and a half lakhs of rupees.

Suitable residences have been constructed for the experts and other officers whose head-quarters are at Dacca. Houses have also been provided at the other agricultural stations for the staff employed there.

Much of the time of the officers of the Department has been occupied in the erection of subordinates' quarters and other farm buildings, in the reclamation and laying out of the various farms, in the construction of roads and wells and other work of an engineering nature. Now that these preliminary operations have been almost completed, the technical officers of the Department will be more free to devote themselves to their proper functions.

Functions of the Department.

3. These functions may be summed up in the two words "Experiment" and "Dissemination." The agricultural stations are established for the purpose of testing new varieties of crops, new implements, and new methods of cultivation suggested by theory or the practice of other countries as likely to give better results than those in common use in the province.

Experiments.

4. A gradual increase of the experimental stations so as to cover the principal varying conditions of the province must be made as money can be found. But at present the first development must be for purposes of demonstration, and it is not advisable to determine too long in advance at what new stations experimental farms shall be started.

Dissemination.

When an improvement has been discovered, it becomes the duty of the Department to bring it to the knowledge of the cultivating classes. This can be done to some extent by the publication of reports and leaflets; but ocular demonstration is the most effectual means of dissemination. No new crop, implement, or method of cultivation should be considered a success unless the increased profits it produces considerably exceed the extra expense involved. Judged by this criterion the success of the following improvements has already been established by experiments on the agricultural stations :—

(*i*) the use of bonemeal manure for winter paddy crops on comparatively poor soil;

(*ii*) the occasional ploughing in of *dhaincha*, cow-peas, or other leguminous crops on any soil that has been long under cultivation;

(*iii*) the use of the turnwrest plough, a strong implement that turns the soil completely over, for breaking up heavy new land;

(*iv*) the use of oil-cake manure for sugarcane and potatoes;

(*v*) the three roller iron mill for crushing sugarcane;

(*vi*) the superiority of striped Mauritius over any variety of sugarcane cultivated in this province;

(*vii*) the advantages of seed potatoes obtained from the hills for sowing in the plains;

(*viii*) prevention of disease in potatoes by spraying with Bordeaux mixture.

District agricultural officers.

5. Though this list of definite successes may seem small, it cannot be doubted but that a very considerable advance will have been made when these improvements have been adopted into current agricultural practice. The first step to this end is to bring them to the knowledge of the cultivators. To attain this object proposals have been submitted to the Government of India for the constitution of a service of agricultural officers, and ultimately it is intended to appoint one such officer to every district. The first duty of these officers will be to study local agricultural practices and conditions with a view to deciding which of the improvements will be most appropriate and effective. They will then proceed to carry out the selected improvements on land borrowed from raiyats. During the progress of the work they will take all the most intelligent villagers into their confidence and explain to them the nature of the improvement, the expense incurred in carrying it out and the results obtained. For success in work of this kind practical skill and knowledge combined with sympathy and tact will be required. To ensure the necessary amount of practical experience the Lieutenant-Governor has decided that no district agricultural officer will be appointed till he has completed two years' practical training to the satisfaction of the Director. Appointments will generally be limited to graduates of an agricultural college.

Promising experiments.

6. In addition to the improvements already tested and proved, there are several promising experiments in progress on the agricultural stations, and it is confidently expected that the next five years will see the transfer of many possible improvements from the experimental stage to the category of established successes. The following instances of promising experiments may be mentioned :—

(*i*) improvement of poor high land soil by application of lime, with or without the addition of bonemeal;

(*ii*) cultivation of Sumatra and other foreign cigar tobaccos;

(*iii*) cultivation of cigarette tobaccos and curing by fire;

(*iv*) thinner planting of rice seedlings;

(*v*) the growth and storage of fodder crops to tide over the periods when fodder is scarce and for the improvement of cattle by adequate feeding.

When any new crop or method has been sufficiently tested and can be confidently recommended for general adoption, it will be taken up by the demonstrating staff.

Fieldmen demonstrators.

7. To assist the district agricultural officers and to carry on demonstrations in districts where such officers may not have been appointed a staff of less highly qualified fieldmen demonstrators will be required. In the memorandum

quoted above, Sir Bampfylde Fuller made provision for ten apprentices on the Dacca Agricultural Station, intending that these youths after two years' training should be appointed fieldmen demonstrators. Sir Lancelot Hare regrets to learn that, owing to the pressure of reclamation and engineering work, insufficient attention has been given to the agricultural training of the apprentices. It must be regarded as one of the most important duties of the Deputy Director and the Agricultural Supervisor to arrange that the apprentices are thoroughly trained in every branch of the work which a fieldman demonstrator is expected to perform, and there must be no hesitation in rejecting any who during the period of apprenticeship show themselves to be unsuitable. With the introduction of district agricultural officers the training of probationers of this class will also be carried out at Dacca, and the Lieutenant-Governor recognizes and expects that the duties of training will henceforth occupy a considerable portion of the time of the Deputy Director of that station. For the training of apprentices the immediate responsibility will rest with the Agricultural Supervisor.

Jute.

8. On the subject of jute valuable preliminary work has been done. Mr. Finlow, Fibre Expert to this Government, working in collaboration with Mr. Burkill, Reporter on Economic Products to the Government of India, has established the fact that *Corchorus Capsularis*, the ordinary jute plant, is normally self-fertilised; the conclusion drawn from this fact is most important, *viz.*, that if any improved race is introduced into a district, only the most ordinary precautions are necessary to prevent it being contaminated by the inferior local varieties. The same experts have also shown that in regard to colour the jute plant follows the laws of Mendel, red being dominant and green recessive. Though colour of plant is not in itself of much importance, these results suggest the possibility that other characters which directly affect the quality of fibre may also be mendelian. Of such characters the chief is the length of the minute filaments of which the fibre is ultimately composed. Investigation is now proceeding to determine the length of ultimate fibre in various races of jute, and the question of the extent to which ultimate fibre length is affected by environment and by heredity acting separately forms the most pressing item of the Fibre Expert's work in the near future. This problem will obviously be of a far more complicated nature than that of the colour of plant, and it has been found necessary to construct a pot-culture house as an adjunct to the Central Farm in order that plants of different races grown under various definite conditions of soil and moisture may be kept under observation together.

Sugarcane.

9. Though owing to the exceeding poverty of the soil the sugarcane experiments on the Jorhat Farm were at first very unpromising, the work done there by Messrs. Meggitt and Birt is now beginning to yield results of great interest and value. The qualities of different local and imported varieties are being carefully studied. Those which prove to be markedly inferior in regard to yield of sugar per acre, saccharose content of juice or susceptibility to disease are being gradually eliminated. Most of those which now remain are the equal of almost any cane in the world. The object of future work should be to increase the yield by intensive culture, as has been done in Java, rather than to experiment with other new varieties. In addition to experiments in the permanent amelioration of the soil, the most suitable kinds and times for applying manure for the immediate requirements of the crop will be studied. A series of experiments has also been commenced to determine the best method of planting.

The work of the past three years has established the fact that by selecting for the next year's plants cuttings from the strongest, healthiest, and best tillering clumps, a very marked improvement is effected in the yield of cane and juice.

Tobacco.

10. The cultivation and subsequent treatment of Sumatra tobacco for cigar manufacture have been considerably improved at the new agricultural station at Burirhat near Rangpur. Successful experiments have also been made in the fire-curing of cigarette tobaccos. After the removal of some defects which still remain, the Department should be in a position to lay down definite instructions for the production of cigar and cigarette tobaccos of good qualities according to the standard of the European market, and should be prepared to distribute large quantities of standard varieties of seed of these two kinds.

Rice.

11. The Economic Botanist has taken up the study of the varieties of *aus* and winter rice most commonly cultivated in this province. As the work has only been a short time in progress, no results can be expected yet, but it is hoped to discover new races which will be improvements on the existing races in respect of heaviness of yield, tillering power, stiffness of straw and other desirable qualities.

Potatoes.

12. As the result of some seven years' experience it is concluded that no variety of potato remains immune to blight in the Khasi Hills. Sutton's Magnum Bonum (which is almost identical with the variety of potato grown around Naini Tal) resists the disease better than any other kind, but after a few years its resistance becomes gradually weaker. The only means by which potato cultivation is to be maintained in the Khasi Hills is that the Department should annually import a large quantity of the most immune variety obtainable in Europe, multiply the tubers by a year's cultivation, and distribute the produce as seed throughout the hills. For this purpose it will be necessary to extend considerably the area under cultivation at the Upper Shillong Farm.

Other crops.

13. Through the medium of the Fruit Experiment Station, strawberries, mulberries, rhubarb, and asparagus have been introduced to some extent into ordinary cultivation around Shillong, and though but little success has been gained with other English fruit, it has been decided to continue the experiments for some time longer, paying attention to the provision of shelter belts of trees and to the selection of stocks and scions of varieties which mature either before or after the heavy rains. Experiments with fruit trees have recently been commenced at Dacca by the Economic Botanist and should lead to an extension of this generally neglected form of husbandry. The tropical plantation at Wahjain has been abandoned, as it did not prove successful. The growing of fodder crops for the cold weather months requires special attention at all the agricultural stations.

Soil improvement.

14. There is one apparently serious disadvantage in the site chosen for the Dacca Agricultural Station, namely the exceeding infertility of the soil. In some respects, however, this is an advantage for the soil is typical of that found extending over wide areas in Dacca and many other districts; the soil of the Jorhat Farm is also very similar in character. Analyses of these soils show that they are very deficient in lime and phosphoric acid and that they have an acid character which is inimical to the bacteria which do so much to promote ordinary plant life. Raiyats find it impossible to get good returns from such land and *rabi* crops can scarcely be grown at all. It will therefore be obvious that a practical solution of the problem of the appropriate treatment for this type of soil will be a very great boon to the province. Experiments at Dacca and Jorhat have already shown that dressings of lime and bone-

meal with occasional green-manuring effect an immediate improvement. Further experiments are now in progress to determine the quantities and doses in which the lime and bonemeal are to be applied to effect the most complete and permanent improvement. Nothing that the Agricultural Department has in hand is of greater importance than this problem.

Housing of cattle.

15. The Lieutenant-Governor's orders in regard to measures for the general betterment of cattle have been issued separately. On this occasion, Sir Lancelot Hare desires only to point out that improvement is necessary in the type of house provided for the accommodation of cattle. At every agricultural station in this province there should be a model cattle shed combining the maximum provision for the health and comfort of the cattle with the efficient conservation of manure, at a minimum cost, well within the means of an ordinary raiyat. According to the site, to the materials most readily available locally, and to the varying climatic conditions, a different type of shed will probably be required for each farm, and it will rest with the Deputy Director and his subordinates to discuss the mattter with local cultivators and officers, and, having ascertained local conditions, devise a model cattle shed.

Sericulture.

16. The work of the Bengal Silk Committee in Rajshahi, Malda, and Bogra has been taken over by Government; all the existing institutions have been maintained and a large seed-rearing establishment has been opened at Mirganj on the bank of the Ganges. In April last, Mr. Fletcher, Imperial Entomologist, inspected all the sericultural stations and has submitted a report which is now under consideration. In accordance with his advice it is proposed to continue the production of disease-free seed, and, as soon as there are indications that the demand for such seed is more than the existing seed-rearing stations can supply, to open a new one in the Malda District. The Imperial Entomologist has kindly undertaken that experiments in breeding a superior hybrid race of multivoltine silkworms will be made at Pusa. All expenses connected with the Sericultural School at Rajshahi are now borne by Government, but the management is still vested in a local committee. Owing chiefly to the difficulty of finding a competent master, the school has not been a great success. Ultimately it may be found necessary to give it a more practical character by attaching it to one of the seed-rearing stations.

Entomology and mycology.

17. For the study of the insect pests and the fungus diseases of crops, the Department has at present only two collectors on pay of Rs. 50—$\frac{5}{2}$—75 a month. The Lieutenant-Governor recognizes that this provision is inadequate for operations on the large scale which alone can be effective. Officers are required with high training, active intelligence, and tact to secure the willing co-operation of large bodies of raiyats. When such officers are available, the Lieutenant-Governor will be ready to move the Government of India to sanction the appointment of an Entomological Assistant and a Mycological Assistant on a suitable salary which may perhaps be intermediate between that of a Farm Superintendent and an Agricultural Supervisor.

Additional staff requirements.

18. The additional staff required by the Department includes two more Agricultural Supervisors, the Entomological and Mycological Assistants just mentioned, a second Superintendent of Sericulture when a new seed station is opened in Malda District, and a number of fieldmen demonstrators. Sir Bampfylde Fuller estimated that twelve fieldmen demonstrators would be required to begin with, but although six passed apprentices are now acting temporarily in this capacity, none of them are yet sufficiently trained to be worthy of permanent appointments. Now that all the agricultural stations are in regular working, a sufficient number of trained demonstrators should soon be available. The Lieutenant-Governor has regretted to notice that the amount of work done by Associates during the past five years is not very considerable, but recognizes that this is largely owing to the want of supervising officers; he hopes, however, that this want will soon be supplied.

Associates and Co-operative Societies.

19. In addition to assisting Associates, the Lieutenant-Governor desires that the services of demonstrators may be occasionally lent to Co-operative Societies, the members of which show keenness in introducing agricultural improvements. In this connection, Sir Lancelot Hare considers that the greatest benefit is to be expected from close communication and active mutual assistance between the Registrar of Co-operative Credit Societies and the Director of Agriculture."

To this it is only necessary to add that in regard to improvement of cattle, the Government has ordered a complete survey to be made of the working and milch cattle of the province and of the conditions affecting their breeding and maintenance. This work will be taken up as soon as an officer can be found competent to make the enquiry. In regard to poultry improvement, considerable success has attended the efforts to introduce good breeds into the Lushai Hills and arrangements are being made to develop this work and to extend it to the Khasi and North Cachar Hills. Substantial progress has been made with the breeding of a good stamp of poultry suitable for raiyats in the plains. The central breeding station at Dacca is under the charge of Mr. Meggitt and arrangements for starting subsidiary stations are being completed.

II.—DEPUTY DIRECTOR, DACCA.

(A. G. Birt, B.Sc.)

The Deputy Director of Agriculture is in charge of the following:—

1. Dacca Agricultural Station, Eastern Bengal.
2. Burirhat " " " "
3. Rajshahi " " " "
4. Jorhat " " Upper Assam.
5. Central Seed Depôt, Dacca.
6. Demonstration work in the southern parts of the province.
7. The Entomological Section.

1. Dacca Agricultural Station.

The work at this station has in the past been mainly of a preparatory nature. Much time was necessarily taken up in clearing and laying out the land, the greater portion of which was originally jungle.

The soil of the high land having proved to be extremely uneven in character, the laying down of large areas under experiment has been up to the present impracticable. However, a certain amount of preliminary work has been done, and this, together with future lines of work, will be described in the following paragraphs :—

Investigations on the improvement of the soil of the high land areas in collaboration with the Agricultural Chemist.—Preliminary experiments indicate that the application of lime and bonemeal in conjunction with green manuring effect a very great improvement in this soil both physically and chemically. Two series of experiments have therefore been laid down this year in duplicate on four acres of typical high land, the object being to study the effect of lime in large and small doses used alone and in conjunction with bonemeal and cow-dung. One series will include green manure in the rotation every second year. This experiment has been laid down for six years.

In connection with the above experiments it is proposed to commence a series of cultivation experiments to ascertain how far the water-holding capacity of the soil in the cold weather can be improved by deeper ploughing and thorough surface cultivation.

Winter paddy.—The experiments in progress include manuring, transplanting, and spacing. Results obtained up to date indicate that soluble manures such as saltpetre, calcium nitrate, sulphate of ammonia, etc., are not profitable owing to their liability to be washed out by flood water. The best results have been obtained from the application of small quantities of bonemeal and by the ploughing in of green manure crops.

With regard to transplanting experiments the results indicate that a considerable reduction in the number of seedlings per acre can safely be made without danger of diminution in outturn.

Future work will consist in further experiments with bonemeal and green manures with and without the application of lime, the more soluble artificials being excluded as unsuitable under the prevailing conditions; the continuation of the planting experiments with special reference to the seed rate in the seed-bed and the effect of early and late planting on the quantity of seedlings required; and the growing of fairly large areas of selected varieties for seed distribution.

Sugarcane.—A small area of the local variety of cane put down two years ago, having done remarkably well, several varieties (including Striped Mauritius,Tanna and Barhados varieties) were brought down last year from Jorhat (Upper Assam) and planted alongside the local varieties. The results were so encouraging that this year the greater portion of the crop has been cut up for sets and about five acres planted. It is proposed to compare the yields of the imported varieties with that of the local variety this year for the first time. Future work will depend largely on the results obtained. If the yields indicate that sugarcane is likely to prove a profitable crop on this type of soil, regular trials of varieties will be made and the question of method of planting and manuring will be gone into.

Green manures.—Work on green manures is being carried out with the Agricultural Chemist and the Economic Botanist. Investigations made up to the present prove that *dhaincha* (*Sesbanea aculeata*) is superior to sann (*Crotalaria juncea*) on both high and low land on account of weight of green matter and nitrogen per acre, and also rate of decay when ploughed in.

It is proposed to extend the work to include other leguminous plants found growing wild in the locality. Up to the present an ideal plant has not been found for the green manuring of winter paddy on low land. *Dhaincha* has been used up to date, but its growth is arrested by water-logging, and the weight of plant ploughed in is comparatively small. The aim is to discover a plant which will stand a certain amount of water-logging in its earlier stages.

Fodder crops.—Joar (Sorghum) has proved to be the best fodder crop for the rains, but as grazing is abundant during that season efforts are being mainly directed to discovering a crop which would come in during the cold weather. The sowing of several crops has been tried, for example, *kheshari* (*Lathyrus sativus*) and sann on the winter paddy land as catch crops to come on after the paddy is harvested, but up to the present time have not been successful. This is practised to a very limited extent in some parts of the province and is worthy of very much wider application, if suitable crops can be found and the right time for sowing ascertained. Experiments with this object in view will be continued.

Trials of implements, etc.—A considerable number of implements new to the province, including Ransome, Meston and Hindustan ploughs, Planet Jr. horse hoes and hand hoes, bullock hoes, chain pumps, etc., are under trial on the farm. As a result of these trials the Department has been able to recommend the Ransome and Meston ploughs and the Planet Jr. hand hoe and there is now a small demand for these implements.

The Ransome plough has been found very suitable for breaking up stiff land, and also for ploughing in green manure crops. Several zemindars and large cultivators have obtained ploughs through the Department.

The work of testing any new implements which are put on the market will be continued and those found suitable for local conditions will be stocked and supplied to cultivators.

Training of students and apprentices.—A course of training in practical agriculture is being given to three students who passed through the Poona Agricultural College, with the object of fitting them for the post of District Agricultural Officer. The period of training extends to two years and it is proposed to have not more than four students under training at the same time. The men selected for training will be graduates of a provincial agricultural college.

The training of cultivators' sons for the post of demonstrator is being continued. Up to the present four men have completed their two years' training at Dacca and have been given temporary appointments as demonstrators on Rs. 20 per mensem. Eight men are still under training; four in their first and four in their second year.

2. *Burirhat Agricultural Station.*

The principal crop under experiment is tobacco. There are also minor experiments with ground-nuts, potatoes, fodder crops, and green manure crops, and also an experiment to test the effect of lime in conjunction with green manure on this soil.

Tobacco.—Experiments on the growing and curing of exotic varieties of tobacco have been carried out on this farm during the last three years. The object aimed at is twofold—the production of a leaf suitable for cigar wrapper and the production of tobacco suitable for the manufacture of good class cigarettes.

At first there was no success, but during the last two years with careful cultivation and better methods of curing undoubtedly superior grades of tobacco have been produced which at the present time find a ready sale in the Indian market at prices four to five times that obtained for the ordinary local country tobacco. For cigar leaf the variety being experimented with is Sumatra. This year $1\frac{1}{10}$ acres were grown which gave a yield of 16 maunds 5 seers of cured leaf. This was sorted into four grades, A, B, C, and D, according to size and quality of leaf, and grades A, B, and C were sold to a Madras firm at the following prices. Grade D was not valued, as it was considered useless for wrapper :—

	Quantity. Mds.	Seers.		Price. Re.	A.	P.			Rs.	A.	
Grade A . .	10	20	at	1	4	0	per lb.	or	102	8	per md. (of 82 lbs.).
" B . .	3	30	"	1	0	0	"		82	0	" "
" C . .	2	25	"	0	12	0	"		61	8	" "

The total amount realised was Rs. 1,545 for $1\frac{1}{10}$ acres. Against this the total cost of cultivation and curing exclusive of rent of land and supervision) was only Rs. 246-9-9.

For the production of cigarette tobacco the chief varieties grown are American, but several Turkish varieties have also been tried. The curing of this class of tobacco at Burirhat has been much improved by the introduction of fire-curing the object being to produce tobacco of a light colour and mild flavour.

The bulk of this year's fire-cured tobacco has not yet been sold, but for a small quantity of Turkish cigarette tobacco (about 1 maund) Rs. 85 per maund have been obtained for the first grade and Rs. 65 for the second grade from a firm in Bombay.

The above results are decidedly encouraging. No doubt the high prices obtained for the above are due to some extent to the import duty on tobacco, yet it is obvious that manufacturers would not buy this tobacco if it were not suited to their purposes, whatever the import duty might be.

The present lines of work will be continued with the object of producing the best possible Sumatra leaf by suitable cultivation and curing. For cigarette tobacco seed of *white burley* has been imported from America and a fairly large area of this variety will be grown for further experiments in fire-curing.

Other experiments.—Ground-nuts and potatoes have been tried on a small scale with indifferent results. Both these crops are liable to disease on this farm. Ground-nuts will be planted wider between the rows next year so that more interculture can be given.

Cow-peas and *dhaincha* are being tried as green manure crops and both do exceedingly well.

Joar has proved to be an extremely useful fodder crop in the rains and earlier part of the cold weather.

For winter fodder, a small area of Guinea grass has been put down for trial.

The soil having been found extremely poor in lime, an experiment to test the efficacy of lime applied in small doses annually in conjunction with green manuring has been laid down at the instance of Mr. Meggitt. It is proposed to grow tobacco annually on one of the lime plots to study the effect of the lime on the quality of the tobacco.

3. *Rajshahi Agricultural Station.*

Experiments at Rajshahi include sugarcane, jute, potatoes, winter paddy, and ground-nuts.

Results up to date show that the Dacca *gandari* variety of sugarcane is superior to the local variety in quality of juice and yield of sugar per acre, but its germinating power and resistance to water-logging are inferior, and this is a serious drawback to it in a locality like Rajshahi where there is likely to be shortage of moisture at planting time and excess of water during the rains.

Work with jute now consists in growing fairly large areas of varieties selected by the Fibre Expert for seed.

Experiments with potatoes have demonstrated the superiority of the Darjeeling variety and have shown that with careful cultivation a crop of two hundred maunds or more per acre can be grown without irrigation.

Manurial and planting experiments with winter paddy have not been successful owing to the difficulty of controlling the water-supply. Ground-nuts have proved a failure owing to water-logging.

As a portion of the farm is to be taken up for the construction of a railway, it is proposed to abandon the place as an experiment station. At present the drainage system in the vicinity of the farm is in a very bad state and the land is liable to sudden floods in the rains.

After the construction of the railway and the improvement of the drainage it is proposed to make the farm the head-quarters of the District Agricultural Officer who will use the land for demonstration purposes.

4. *Jorhat Agricultural Station.*

The two chief lines of work at Jorhat are experiments with sugarcane and investigations into the treatment of the soil, both of which are being done with Mr. Meggitt, Agricultural Chemist.

There are also minor experiments with ground-nuts and potatoes.

Sugarcane.—Experiments during the past three years have shown that the striped Mauritius variety is superior in all respects to the local varieties, and that some varieties imported from Barbadoes are also suitable for this locality.

The future lines of work will be the further testing of varieties, trials of various methods of planting with the superior varieties, and manurial trials with the object of economically raising the outturn of sugar per acre.

Soil improvement experiments.—This work is being conducted on very similar lines to that at Dacca, the soils of the two places being very similar in some respects, notably their poverty in lime and phosphate. The Jorhat soil is, however, very much better physically than the Dacca soil, being more retentive of moisture in the cold weather and lighter in texture.

Preliminary experiments showed the marvellous effect of lime on this soil and consequently liming has been made the basis of the experiment. It is being applied in varying quantities with and without bonemeal and cow-dung, while green manuring is being introduced into one series of plots.

The experiment has been laid down for six years.

Ground-nuts have grown well during the last two years, but great difficulty is found in protecting them against rats. It is proposed to continue experiments with this crop, and, if it proves a financial success and a local market can be found, to induce cultivators to take up its cultivation.

Potatoes have been successfully grown on a small scale as a demonstration rather than as an experiment in order to introduce the crop to the locality.

5. *Central Seed Depôt, Dacca.*

The seed depôt was started about three years ago with the object of supplying pure seed of high germinating power to the general public. Up to the present the demand for such seed has not been large, but it is gradually increasing as the depôt is becoming better known.

The chief work of the seed depôt up to the present has been to stock seed of crops new to the province and also special varieties of crops grown in certain parts of the province for which there is a demand in other districts.

In this way quantities of potatoes and special varieties of jute and paddy seed have been distributed. Improved implements are also distributed from the depôt. In future the chief duty of the depôt will be to distribute special varieties of seed recommended by the Department.

6. *Demonstration Work.*

A commencement has been made with demonstration work on the use of bonemeal for paddy in the Dacca District, and this work will be further extended in future. The demonstrations are being carried out on cultivators' holdings by four demonstrators under the supervision of an Agricultural Supervisor.

The results obtained on the *aus* paddy crop were in some cases astonishing, increases of more than 100 per cent. being recorded by the use of 3 maunds of bonemeal per acre. The effect will also be measured on the winter paddy crop.

Potato demonstrations in four districts, *viz.*, Dacca, Mymensingh, Rajshahi, and Pabna, are being carried on during the present cold weather.

Demonstrations in the Assam Valley will be commenced with the object of introducing the striped Mauritius variety of sugarcane and the cultivation of potatoes to the notice of cultivators.

While on tour the demonstrators will show the use of improved implements, such as the Meston plough and Planet Jr. hoe, in the cultivation of the crops to be demonstrated with.

As far as possible, advice and help will be given to agricultural correspondents and others who wish to make experiments on their own account.

7. *Entomological Section.*

At present there is only a collector on Rs. 50 to Rs. 75. His time is largely taken up in visiting places from which reports of insect attack are sent in.

Two special pieces of work are in progress and will be continued ; one is the prevention of the mango weevil and the other the investigation of the disease of paddy termed " ufra." The results of the investigations into the disease up to date tend to confirm the suspicions that in some places it is caused by insect attack and in other places by a fungus.

III.—DEPUTY DIRECTOR, SHILLONG.

(J. N. CHAKRAVARTY, B.A., M.S.A., AGRICULTURAL SUPERVISOR IN CHARGE.)

1. *Upper Shillong Farm.*

Potatoes.—Trials of new varieties will be continued. Past experience having shown that it is impossible to keep any variety altogether free from disease, fresh seed of the variety which has so far proved the most immune will be imported directly from England and grown on as large a scale as practicable for sale as seed. The experiments contrasting (1) cut sets—*v*—whole sets and (2) methods of planting, will be continued. The manurial and spraying experiments having given definite results have been discontinued. The experiment in planting sprouted tubers was abandoned, having yielded no useful results. A new experiment has been started to compare summer grown with winter grown seed, the usual local practice being to save seed from the summer grown crop ; this will be continued.

Fodder crops.—Maize.—New varieties will be tried and improvements in cultural methods (use of drills for sowing and of bullock hoes for interculture) will be attempted.

One of the local grasses (*U. langtylli*) has proved a good fodder crop and its cultivation will be extended. *Euchleana mexicana* and other new fodder crops will be tried.

Soybean.—Different varieties are being grown for trial.

Treatment of soils.—There is a large area of marshy land on the farm which is being gradually reclaimed by draining. An experiment to test the effect of liming will be tried on a small scale.

Cattle-breeding.—The breeding of Patna bulls for the Khasi Hills will be continued.

Sheep-breeding.—The crossing of Khasi ewes with Dumba rams has already given encouraging results and this will be continued on a larger scale.

2. *Rangpur Demonstration Farm.*

This farm has been taken over by Government from the 1st August from the local Agricultural Association and is to be used primarily as a demonstration and seed farm. Improved varieties of jute, paddy, potatoes, and sugarcane are to be grown for demonstration and seed. Growing of cow-peas for green manuring will be continued.

Sugarcane.—Striped Mauritius, striped and yellow Tanna and Dacca *gandari* will be compared with the local sugarcane. Joar, oats, and peas will be grown for fodder and an attempt will be made to introduce these crops among the raiyats.

3. *Fruit Garden, Shillong.*

Experiments to test the suitability to the Khasi Hills of various kinds of fruit trees grown in temperate climates will be continued. Special attempts are to be made to develop suitable varieties by grafting foreign varieties on native stocks and by selection.

Sericulture.—The rearing of European silkworms will be continued. Three Khasi boys trained at Rajshahi at Government expense are expected to start rearing on their own account during the next two years.

4. *Demonstrations.*

The main feature under this head is the appointment of a District Agricultural Officer for Rangpur during the present year. It will be the first duty of this officer to closely study the agricultural conditions of the district and then to demonstrate on raiyats' holdings improvements recommended by the Department. He will spend most of next year in making an agricultural survey of the district. Demonstrations commenced by the Agricultural Association will be continued, including the introduction of Dacca *gandari* sugarcane and the advantages of green manuring for potato cultivation.

In the Khasi Hills previous demonstrations of the use of bonemeal (without the addition of any soluble manure) as a fertiliser for winter paddy have yielded encouraging results, and this work will be continued on an extended scale. The benefit of spraying potatoes with Bordeaux mixture will be further demonstrated. The grafting of fruit trees is being taught to owners of orchards in the Khasi Hills and will be continued. The trial of *Buri* cotton in certain hill tracts will be continued.

IV.—FIBRES.

(R. S. FINLOW, B.Sc., F.C.S.)

I. *Short account of work completed or in progress.*—In collaboration with the Reporter on Economic Products—

(*a*) The preparation of a final account of the classification of the races of jute is almost complete and will be published at an early date.

(*b*) An account of the results so far obtained from experiments in the cross-fertilization of jute is now ready for the Press.

2. The experiments with the object of investigating the possibility of the improvement of jute by selection were continued during the year. Previous results showed considerable differences, chemical and microscopical, between the fibre produced from different races grown in the same field, and it seemed possible that a method of selection might be based on these differences. Later results, however, indicate that the effect of soil, climate, etc, both on the chemical composition and on the microscopical structure of the fibre, may also be considerable. The observed variation in chemical composition due to one or both of these causes, in the case of jute, amounts to 9 per cent. of cellulose *or about 15 per cent. of the total cellulose content* of the fibre. Pot-culture trials are now being carried out with the object of definitely deciding whether variation in composition of the fibre is entirely caused by environment or whether a portion of it is due to a hereditary capacity in some plants for producing superior fibre. It is interesting to note that C. D. Mell, (*vide* American Forestry Quarterly, Volume VIII, No. 4,) has observed similar differences in the microscopical structure of the wood of Californian forest trees. In the abovenamed Journal he quotes results obtained for the wood of the Californian walnut (*Juglans californica*).

3. (*a*) Preliminary trials on a small scale with flax in Assam have given encouraging results as regards both straw and grain, and it is now practically certain that a block of about 5 acres will be put down at Baihata in the coming season.

(*b*) A set of plots designed to throw light on the manurial requirements of flax was, with the approval of the Inspector-General of Agriculture, laid down at Pusa in the season 1910-11. The series included farm yard manure, green manure, and mineral fertilizers. Unfortunately the appearance of dodder has rendered it advisable to discontinue the cultivation of flax at Pusa for a time, but the work may be continued at Dooriah.

(*c*) No time has been available for systematic work on the remaining items in the last programme submitted to the Board. It has however been possible to make certain observations on the conditions affecting the speed of the *process of retting in the extraction of fibres like jute, flax, sann, hibiscus, etc.* Some useful information has also been gained regarding possible sources in Assam, of material suitable for paper-making.

Programme of Work.

(*a*) The preparation of a monograph on jute will occupy a considerable amount of time.

(*b*) In collaboration with Mr. Burkill, the experiments in the hybridization of jute will be continued and, if possible, brought to a conclusion.

(*c*) The work described in paragraph 2 above will be continued with the view of completing the investigation into the possibility of improving jute, and other best fibres, by selection.

(*d*) The extension of flax cultivation into Assam will receive attention.

(*e*) The following items which have appeared in former programmes will be taken up systematically as soon as opportunities occur :—

(1) Study of retting of jute.

(2) Investigation of heart damage in jute.

(3) Investigation of sources of material for paper-making.

V.—AGRICULTURAL CHEMISTRY.

(A. A. MEGGITT, B.Sc.)

1. *Work on sugarcane in collaboration with Mr. Birt will be continued.*—Up to the present the work has consisted chiefly of varietal trials with the object of finding varieties superior to the local canes and suited to local conditions.

As a result of very careful comparative study along several lines, *e.g.*, weight of cane per acre, composition and purity of juice, germinating power, relative rate of growth, ratooning and tillering powers, comparative rate of ripening, uniformity of ripening amongst individual varieties, freedom from disease, tendency to split, or excessive lodging, it is found that the variety best suited to the conditions is striped Mauritius, followed closely by some of the Barbadoes seedling canes.

Striped Mauritius is being actively disseminated, while the distribution of other varieties is being pushed as their suitability is proved. Planting experiments are now being instituted, with which will be combined later on manurial work, the object being to increase the outturn per acre as far as such is distinctly profitable. We are convinced that the problem of close *versus* wide planting of cane is intimately connected, especially on poor soil with the manurial treatment.

2. *Investigation of local soil problems with Mr. Birt.*—Many large tracts of soil in Eastern Bengal and Assam present interesting and peculiar characteristics, being very deficient in calcium carbonate, acid in character, often extremely poor in total as well as available phosphoric acid, and more or less deficient in nitrogen and organic matter. It is extremely difficult on such land to grow cold weather crops, and though this is connected in some cases with lack of moisture, this is not the only cause. Special studies are being made with regard to reaction, chemical and physical characteristics, with a view to the general amelioration of these soils. Their requirements for lime, phosphoric acid, and organic matter with special reference to the correction of acidity where it exists, and to the improvement of their permeability in some cases, and the retentive capacity for moisture during the cold weather months, are being worked out, and field experiments on a large scale have been laid down in this connection.

Results to date show that the effect of adding lime and phosphoric acid as bonemeal, and the incorporation of green manure has proved to be pronounced on the *rabi* cropping, the effect of lime alone in some cases being to produce an 8 to 12 annas crop where none would grow at all before. Extreme poverty in calcium carbonate and phosphoric acid would appear to be the chief limiting factors in many of our soils.

In some cases the effect of green manuring without lime, while showing an improvement in cold weather cropping, has not been great as might have been expected. Relative to field work, laboratory work will be undertaken to determine the effect of the manures used on crop composition, in connection with a study of the requirements of various crops and removals of plant food, and the subsequent adoption of suitable rotations, and that form of manurial practice best calculated to supply crop demands at the least cost, while leading up to the soil's general and permanent amelioration.

3. *Work on some phases of the problem of green manuring with Messrs. Birt and Hector.*—In connection with the soil problems, green manure crops are required to meet various conditions, *e.g.*, of soil, of period and season of growth, *of power to resist water-logging, etc.*

So far this work has been continued to a study of two crops, *dhaincha* (*Sesbanea aculeata*) and sunn hemp (*Crotalaria juncea*), the lines of comparison being weight of green matter produced per acre, weight of dry organic matter, weight of nitrogen contained in the crop, root range and comparative nodule development, facility of incorporation with the soil, and relative rate of decay after ploughing in. Results to date show that both do well but that *dhaincha* in Eastern Bengal easily leads on all counts.

This work will be extended to other green legume crops to meet various requirements.

4. *Work on the nutrition of the winter paddy crop.*—Object; to ascertain its food requirements and the period of growth during which the individual food factors are chiefly required and absorbed. The crop lives its life under such extraordinary conditions as regards water, that any manurial work to be done must be very carefully considered to ensure the most economical use of the manure used. It is proposed to study the matter from a series of samples consisting of entire plants taken throughout the whole growing period of the crop, from typical winter paddy land normally producing a good average outturn per acre.

5. *The Kadamara disease of paddy will be considered.*—This disease causes much loss in certain parts of the province and is apparently due to acidity as a result probably of excessive butyric fermentation in the presence of much organic matter, a deficiency of calcium carbonate, and insufficient aeration.

After the necessary chemical examination, remedial measures based upon it will be proposed.

6. *Routine analytical work.*

VI.—ECONOMIC BOTANY.

(A. G. BIRT, B.Sc., IN CHARGE.)

1. The laying out of about 14 acres of land as a botanical area has been completed. About 4½ acres is reserved for fruit, while the remainder is intended for the cultivation of the various crops under investigation. A six-feet diameter pucca well has been sunk to irrigate the fruit area and it is proposed to construct two more similar well as funds are available.

2. *Rice.*—A collection of the more important varieties of *aus* and *aman* rice in the province has been made and these are being grown for selection work. This work will be continued, selection being made on the single plant system with the object of isolating superior races.

3. *Tils, mustard, pulses and chillies.*—A survey of these crops is being made, and for this purpose a large number of varieties of each have been collected from all parts of the province.

4. *Fruit.*—Experiments have been commenced with the object of determining what fruits can be grown successfully in Dacca District.

The following fruit trees have already been planted out in the fruit area :—

1. Mangoes	6 varieties.
2. Lichis	4 „
3. Guava	1 variety.
4. Pomelos	2 varieties.
5. Limes	2 „
6. Citrus	2 „
7. Custard apple	1 variety.
8. Bullock's heart	1 „
9. Pine-apples	7 varieties.

A large number of several varieties of citrus stocks are being brought from the Khasi Hills for orange budding experiments. As most varieties of citrus have been found to be immune to the orange disease which is rife in the Khasi Hills, the object of the budding experiments is to find a suitable stock on which to bud oranges which it is hoped will then be also more or less immune to the disease.

5. *Green manure plants.*—In collaboration with the Agricultural Chemist and Deputy Director of Agriculture investigations as to the suitability of various plants for green manure are in progress.

In this connection a large number of leguminous plants, both cultivated and wild, are being grown for observation. This work will be continued.

6. *Herbarium.*—A commencement has been made to form a reference herbarium of the more important cultivated and wild plants of the province. The collections will be gradually extended.

7. *Mycology.*—At present the staff consists of the Collector on Rs. 50 to Rs. 75. He is chiefly engaged in collecting specimens of fungi which are forwarded to the Imperial Mycologist.

Special investigation will be made into a disease of paddy termed " ufra " and also a betel-nut palm disease which has recently appeared in the Goalpara District.

8.—BURMA.

(H. CLAYTON, I.C.S., OFFICIATING DIRECTOR OF AGRICULTURE.)

The following are the chief lines of work proposed for 1912-13. Special efforts will be made to get the Department into close touch with the agricultural population of the province. The co-operative societies, now numerous, will be utilised as far as possible as intermediaries for this purpose.

I.—DEPUTY DIRECTOR, NORTHERN CIRCLE.

(E. THOMPSTONE, B.Sc.)

Mandalay Agricultural Station.

1. *Paddy.*—Experiments with this cereal include (*a*) manurial cultivation with locally available manures, artificial manures including Nitrolim and green manures as mentioned in previous programmes; (*b*) trials of exotic varieties; (*c*) selection, production, and distribution of seed of approved varieties. The following experiments were started this year, and will continue during 1912-13 :—

(*i*) Rotation and cultivation experiments.

(*ii*) Methods of sowing and planting.

(*iii*) Water measuring experiments.

2. *Wheat.*—The experiments with this crop will be reduced in numbers owing to the unsuitability of the soil. Some of the more promising ones will be continued as previously. Seed will be produced as in previous years.

3. *Cotton.*—The work proposed in the programme for 1910 will be continued.

4. *Ground-nuts.*—These will be cultivated for seed purposes only.

5. *Jowar and maize.*—Selection and classification of indigenous and exotic varieties.

6. *Peas and beans.*—Classification in the field of the large number of indigenous varieties as previously.

7. Experiments in fruit culture already begun will be continued.

8. *Other crops.*—In rotations and on land which is being brought under cultivation or which is not required for experimental purposes.

9. *Implements.*—The simpler ones will as previously continue to be manufactured in the farm work-shop. Several new ones will be imported and tried, and approved types will be brought to the notice of cultivators. Government has approved of a scheme for the importation by this Department of approved but cheap types of agricultural implements. These will be stored at the Mandalay station for sale on easy terms to cultivators.

10. *Seed.*—Selection, improvement, production, and distribution with as many crops as possible will be continued.

11. *Taungya* experiments already begun at a branch of this farm at Thandaung will be continued.

12. *Demonstration* at approved centres. Work at two places has already been commenced on rented land.

13. *Poultry-breeding* which has met with some success will be continued and extended.

14. *Educational.*—(*a*) Conduct of classes and short courses of practical instruction for the farm staff and others desirous of attending.

(*b*) Training of agriculturists for district work.

(*c*) Collaborating with the Educational Department in respect of school gardens, nature study, etc.

15. *District work.*—This will include tours in connection with agricultural enquiries, assistance to rural societies and to teachers starting school gardens. Attention to outside experimental work and demonstration plots.

16. *General work.*—The writing of notes, leaflets, etc., the collection of seeds and economic products, and the supervision of the Botanical and Entomological Departments.

II.—DEPUTY DIRECTOR, SOUTHERN CIRCLE.

(A. McKerral, M.A., B.Sc.)

(*i*) *Hmawbi Agricultural Station.*

1. Thirty acres of the farm have now been laid out in ¼ acre plots. These are being standardized by uniform cropping with one variety of paddy which will be continued during 1912-13.

2. Experiments with improved implements—ploughs, winnowers, and reaping machines—will be conducted.

(*ii*) *Agricultural Surveys.*

These are meant to obtain accurate information as to general agricultural practice and economy, the knowledge so obtained to serve as a basis and guide for future work on experimental stations. The Districts of Myingyan and Sagaing have been completed. Yamethin is now in hand and will be completed in October 1911. During 1912-13 the survey of the Hanthawaddy District will be undertaken.

(*iii*) *Economic Surveys of Plant Varieties.*

The object of these is to classify the varieties of the chief cultivated crops according to their botanical structure, their general habits of growth and their economic qualities. The work is meant to supply information which shall serve as a basis for plant breeding and improvement and to furnish pure cultures for that purpose. During 1912-13 the following surveys will be commenced :—

(*a*) The Lower Burma paddies at Hmawbi.

(*b*) The Burmese sessamums on a plot of land to be acquired for the purpose in the dry zone area.

(*iv*) *District Work.*

This will consist in the introduction of new staples, the extension of cultivation of already existing ones, and advice on agricultural matters generally to district officers. During 1912-13 an attempt will be made to introduce the cultivation of arhar (*Cajanus indicus*) into the Thayetmyo District.

III.—AGRICULTURAL CHEMISTRY.

(F. J. Warth, M.Sc.)

The work of the Agricultural Chemist will comprise :—

1. *The chemical examination of paddy mill products.*—This work has two main objects. First,—the determination of the qualities in rice which favour good milling and second,—the discovery of the rice varieties which are least likely, when milled, to cause beri-beri, which disease has been attributed to the lack of nitrogen and phosphates in the grain at present exported from this province.

2. The chemical examination of some paddy varieties grown on the Mandalay station and in pots. A certain amount of preliminary work has been done during the past two years under this head. The objects of this enquiry are to determine the normal amounts of plant food absorbed by different varieties and to observe the effect of manures on the organic and inorganic composition of the plant.

3. *Paddy irrigation.*—The following enquiries have been commenced :—

(*a*) Chemical examination of some irrigation waters. This is a continuation of the work touched upon in the silt report.

(*b*) A study of the changes which water undergoes when used for irrigation. The object is to determine how far irrigation helps to fertilise and aerate the paddy crops.

4. *Paddy soils.*—An examination of the chief paddy soils of Burma. This work, which includes chemical analyses and pot cultures, is now in progress and will probably be considerably extended. The object of the enquiry is to determine the relative fertility of these soils, and to ascertain whether any particular varieties are specially suited to particular soils.

5. *Classification of the chief soils of the Yamethin District.*—This work is being undertaken in co-operation with Mr. McKerral in connexion with the agricultural survey of the district. The analysis of the typical soils of the Meiktila District was completed last year and will appear in the settlement report.

6. *A study of Taungya soils.*—This enquiry involves mainly chemical analyses and has been undertaken by order of the Local Government.

7. A series of experiments on the utilization of slaughter-house products as manure will be undertaken.

IV.—ECONOMIC BOTANY.

The Botanical Assistant will be engaged on the following work in collaboration with the Deputy Directors, Northern and Southern Circles :—

1. *Crop surveys*—

(a) Completion of the pea and bean survey.

(b) Survey of the Lower Burma paddies.

(c) Survey of the Burmese sessamums.

2. Continuation of the study of the oils of Burma.

3. Collection and preparation of economic products and specimens.

V.—ENTOMOLOGY.

The Entomological Assistant will be engaged on the following work under the supervision of the Deputy Director of Agriculture, Northern Circle :—

1. The work of the past year in studying and advising on crop pests will be continued.

2. Experiments on white-ants, brown cotton coccidæ, and other insect pests will be continued.

3. Eri-silk cultivation will be commenced at the Mandalay Agricultural Station on a small scale, the object being to ascertain the effect of the climate on the worms.

4. Classification of insects.

5. Introduction of the parasites of the cotton boll worm.

VI.—GENERAL.

The issue of leaflets and bulletins as occasion arises.

9.—NORTH-WEST FRONTIER PROVINCE.

(SUPERINTENDENT OF FARMS, W. ROBERTSON BROWN.)

Agricultural Stations.

Peshawar	100 acres.
Haripur	20 „

Fruits.—The distribution of plants of superior local and imported varieties of fruits which grow in the North-West Frontier Province and the encouragement of fruit culture in suitable districts. The continuation of work in the introduction of wood-wool for the packing of fruits.

Wheat.—The continuation of work in connection with the classification of the wheats of the North-West Frontier Province. The carrying out of trials, in the districts of the province, of the pure Punjab types of wheat which showed outstanding merit in the Peshawar trials in 1910. Trials of some of Mr. Howard's Pusa wheats.

Sugarcane.—The examination of the local varieties and the continuation of the trials of imported kinds.

Cotton.—The continuation of the examination and trials of North-West Frontier Province cottons and a further trial of American and Lyallpur selected kinds.

Jowar.—The distribution of seed of *Sorghum saccharatum*, and Sorghum "Lyallpur Sweet." These varieties were markedly superior to the Peshawar Sorghums in 1911 trials.

Maize.—The continuation of the trials of local and American varieties. Efforts will be made to regenerate certain American varieties which were successfully introduced many years ago but which cannot now be procured pure.

Tobacco.—The continuation of the selection of superior local types of *Nicotiana rustica*. The trial of imported kinds.

Chillies.—The continuation in the selection of superior fruiting types and in the trials of imported kinds. Investigation as to the predisposing cause of the periodical recurrence of the disease, "Colletotrichum nigrum."

Other crops.—Oats from Behar, England, Australia, and America will be tried in 1911-12. Soybeans and groundnuts will be given further trial.

Implements.—The continuation of the trials of labour-saving implements and the introduction of some of those where conditions are favourable.

Tillage and cultivation.—The continuation of the trials in deep *versus* shallow ploughing and the trials in methods of cultivating sugarcane, cotton, red pepper, tobacco, maize and other crops which are important in the North-West Frontier Province.

Entomology.—The establishment of a working collection of the more important, useful and injurious insects which affect farm and garden crops in the North-West Frontier Province. A small museum is to be attached to the Peshawar Agricultural Station, and an agricultural assistant, who has been trained in Entomology at Pusa, will be in charge.

Shows and demonstrations.—The exhibition at shows and fairs of superior varieties of agricultural produce, and the demonstration of the uses of improved agricultural implements.

Poultry.—The breeding and distribution of Buff Orpingtons—the breed which has been satisfactory at the Peshawar Agricultural Station.

10.—MYSORE.

(Leslie C. Coleman, Ph.D.)

I.—*Agriculture.*

The experimental work on the farm has chiefly to do with the three important crops, *ragi*, paddy, and sugarcane. The experiments originally planned by Dr. Lehmann have been, for the most part, continued, but here and there necessary modifications have been made. As more land has, through continued cropping, come into condition for experimental purposes, additional experiments have been and are being begun. The Government has just sanctioned an increase in the size of the farm of 20 acres (10 of wet land and 10 of dry land), but the land has not yet been acquired. The additional wet land will be utilised largely for testing varieties of sugarcane and paddy and for growing seed for distribution, while the additional dry land area will be partially utilised for the cultivation of ground-nut varieties and experiments on the conservation of soil moisture as well as for work on dry land crops other than *ragi*. It is hardly necessary to add that this work will necessitate an increase of the staff. This need will, to a certain extent, be filled by the return of an assistant who has undergone two years' training in Agriculture at Cambridge.

2. *Experiments with ragi.*—These consist in experiments to ascertain the value of green manures for this crop, the best season for sowing the ordinary variety, interculture experiments, the use of the improved ploughs as compared with the country plough, the use of the sub-surface-packer for the conservation of soil moisture, the rotation of ground-nut with *ragi*, the effect of selecting seed by the salt water method and a comparison of the value of green manure with addition of small quantities of phosphates and potash on the one hand with ordinary farm yard manure on the other.

(*a*) *Green manure experiments.*—The leguminous crops being used as green manures are sann hemp, cow-pea, green gram, black gram, and *avare*. The results of the past two years indicate that care must be taken to allow for a considerable time between the ploughing in of the green manure and the sowing of the *ragi*. The green manure is being applied in three different ways :—(1) An early variety of *ragi* is grown which is harvested in September. The green manure crop is then sown and is ploughed in as soon as the early rains come in February or March. (2) The green manure crop is sown early in May and is ploughed in before the sowing of the *ragi* in July. (3) The green manure crop is sown with the *ragi* and is ploughed in either entire or after harvesting the pods, after *ragi* has been harvested.

Of all the green manure crops, only cow-pea, either alone or manured with small quantities of potash, potash and phosphates, or castor-cake, has, up to the present, had a markedly beneficial effect. As, however, the use of green manure on dry lands is likely to have a cumulative effect, these experiments are being continued.

(*b*) *Seasonal sowing.—Experiment.*—There is considerable variation in the time when *ragi* is sown in different parts of the State and, to ascertain the most suitable time, sowings are made at intervals from April to August. The results for the last two years have been almost completely concordant in their nature and show that yields increase, almost uniformly from the April to the August sowings, the best results being obtained by sowing during the first week in August. The usual time for sowing is early in July. These results have a very important bearing on the use of green manures, if they are corroborated by later results. Sowing in August will allow of a more thorough decomposition of the green manure and so should yield decidedly better results than are now being obtained.

This series of experiments will be partially discontinued after the present season, the earlier sowings which have given very poor results being discontinued. The later sowings will be continued for at least another season.

(*c*) *Interculture experiments.*—In a large part of the State, *ragi* is sown in rows five inches apart. This allows for practically no interculture after the crop has got up a few inches. In other parts, however, the rows are as much as 12 inches apart and here the small bullock hoe is used for interculti vation. Experiments have been just begun to test the effects of different widths of planting, the greater widths allowing for intercultivation.

(*d*) An experiment has just been begun to test the effect of deep ploughing with an improved plough as against shallow ploughing with the country plough.

(*e*) *Conservation of soil moisture.*—Previous to his retirement, Dr. Lehmann purchased a Campbell's sub-surface-packer for trial. Owing to lack of available space, it could not be tried until last year when a piece of land was leased for the purpose. The results of its use were very favourable, although I was quite prepared for the opposite as the advertising methods of the inventor are hardly such as to excite confidence. It is being tried again this year and the prospects are again promising.

(*f*) *Rotation of ragi and ground-nut.*—No experiments have, as yet, been begun to ascertain the value of this rotation, but it is hoped that properly standardised plots will be available for beginning experiments next summer. The cultivation of ground-nut is extending in Mysore and the question is an important one.

(*g*) *Selection of seed by the salt water method.*—The salt water method of selecting paddy seed (*i.e.*, immersing the seed in a salt solution of given strength and then using only the seed which sinks) is, as is well known, extensively practised in Japan and apparently with very satisfactory results. The results from using this method for paddy on the farm here have also been highly satisfactory. It was then decided to extend the experiment to *ragi* also, although quite as satisfactory results are hardly to be expected. Preliminary experiments have shown that this method does actually select the heaviest individual grains and also yields a sample giving about double the percentage of germination as compared with the unselected seed. The growth in the plots sown with selected seed has been decidedly superior to that from that unselected, but definite results will be available only after the harvest in November. Should the anticipated results be obtained, the experiment will be continued and arrangements for demonstration work will be made.

3. *Other dry land crops.*—(*a*) *Introduction of maize varieties.*—The eleven varieties imported from the United States in 1909 have been grown on the farm and have done very well. In order to avoid the dangers of cross-fertilization the three most suitable varieties have been selected for further growth for seed distribution.

(*b*) *Potato cultivation.*—Potatoes are ordinarily sown in Mysore in rows from nine inches to two feet apart. Experiments conducted have indicated that practically the same yield and a better quality of crop can be obtained by sowing in rows two feet apart while a very great saving of seed is thereby effected. At the same time, the bacterial disease which attacks potatoes does not spread nearly so rapidly where the lines are further apart. Arrangements are being made to carry out demonstrations in this connection in potato-growing areas.

(*c*) *Dry land lucerne.*—The three varieties of drought-resistant lucerne (Arabian, Turkestan, and Sand Lucerne) which were sown during the summer of 1910 have made a very promising growth. Some seed has already been collected and this acclimatised seed should yield even more favourable results. This crop should prove useful, especially to landholders near large towns who frequently find great difficulty in keeping their lands under cultivation on account of scarcity of labour. As soon as a sufficient quantity of seed is available, it will be distributed in small quantities to selected landholders.

4. *Irrigated crops.*—(*A*) *Paddy.*—The experiments laid down in the last programme have been continued and further ones are being added. The results of experiments extending over four seasons are being prepared for issuance as a bulletin. Some of the more interesting of these are as follows :—

(i) *Green manuring with sann hemp and cow-pea.*—The results have been on the whole good where a satisfactory growth of the green manure has been obtained. As two crops of paddy per year are grown, some difficulty has been experienced in obtaining a growth of the green-manure between the two crops. This is now being obviated by sowing the seed in the paddy before the harvest, thus allowing for about three weeks' longer growth of the green manure. This will be continued.

(*ii*) *Use of saltpetre as a manure.*—This has proved unsatisfactory and unprofitable and will be discontinued.

(*iii*) *Use of a complete artificial fertilizer (Basic slag, potassium sulphate and saltpetre).*—This has not proved profitable, but will be continued with the substitution of ammonium sulphate for saltpetre.

(*iv*) *Use of castor-cake as a fertilizer.*—The results are on the whole favourable, but have not been entirely uniform. The experiment will be continued.

(*v*) *Cultivation experiments.*—(*a*) Transplanting has given better results than broad-casting, but the difference has not been so marked as was expected. (*b*) Sowing sprouted seeds has given poor results and will be discontinued. (*c*) The experiment on deep and shallow ploughing has as yet yielded no marked difference in results. It will, however, be continued. (*d*) Ploughing in puddle just before transplanting has yielded consistently better results over four seasons than ploughing immediately after harvest. This rather unexpected result is very interesting and indicates that the ordinary views as to sound cultivation methods cannot be applied to paddy. This experiment will be continued and an attempt will be made to discover the reason for this unexpected result.

(*vi*) *Rotation of paddy with Bengal gram.*—The results of this experiment have been satisfactory as far as the paddy is concerned, but the Bengal gram has, owing to insect attack and other causes, been practically a total failure. The experiment is being continued with the substitution of an irrigated variety of Avare (*Dolichos lablab*) obtained from Bombay, in place of the Bengal gram.

(*vii*) *Seed selection by means of salt water.*—This experiment which has been in progress only a year has given very good results. It will be continued and an attempt will be made to increase the yield still further by a second selection from the seed from a selected plot.

(*viii*) *Paddy varieties.*—Twenty-five varieties of paddy which were collected over a year ago have been kept going in small plots on the farm. With the extension of the Farm an opportunity will be offered for testing these varieties, especially with regard to their water requirements, a particularly important matter in Mysore where, in certain districts, the water-supply is uncertain.

(*B*) *Sugarcane.*—The chief experiment in connection with sugarcane was devised to ascertain through how many months of the year cane can be profitably planted in Mysore. This is important in connection with the utilization of improved machinery for milling and boiling. The experiment as originally planned by Dr. Lehmann called for growing cane on seven plots planted at intervals of 52 days throughout the year. Each plot would, at the end of seven years, have had cane on it planted at each of the seven different seasons. The experiment has had, however, to be modified as it was found that the constant cropping with sugarcane was bringing about a rapid deterioration. Alternate plots are now being reserved for a rotation crop of potatoes. This crop was chosen for the rotation from the fact that it can be put in almost at any time throughout the year. The experiment as so altered is being continued.

Other experiments on sugarcane deal with a rotation of the cane with (*a*) ground-nut, (*b*) cow-pea, and (*c*) paddy, and are being continued.

Introduction of varieties.—The Mauritius varieties introduced from Samalkota are being grown in a small way and are doing very well. With an extension of the farm more space will be devoted to them and seed of the best will be available for distribution. Two varieties new to the State (B208 and Vellai from Coimbatore) are being grown for the first time this year.

II.—AGRICULTURAL CHEMISTRY.

The work in the Chemical Laboratory will, as in the past, be largely connected with the experiments carried out on the Experimental Farm. The smallness of the staff necessitates this. With the return of the assistant who is at present undergoing training in Agricultural Chemistry in Germany, additional work will be attempted. In the meantime the work will consist chiefly of (*a*) an estimation of soil moisture throughout the year under different systems of cultivation, (*b*) chemical control of the sugarcane experiments, (*c*) if time permits, a resumption of the work on nitrification in soils, (*d*) a preliminary study of paddy soils ploughed after harvest and ploughed just before transplantation, and (*e*) analyses of soils and manures for raiyats and land-holders.

III.—MYCOLOGY.

Koleroga of Supari.—Work on this very important disease of the areca palm, which causes annually losses exceeding 2 lakhs of rupees, is now in its fourth year. Demonstration work in connection with spraying has grown rapidly. In this work sprayers are loaned by Government, but the expenses of material and labour are borne by the garden-owners. The amount of work done in each of the last three years is as follows :—

Year.	Number of gardens sprayed.	Acreage sprayed.
1909	6 (experimental and at Government expense)	4
1910	46 (2 do. do.)	25
1911	91 (2 do. do.)	65

The work seems now to have reached a stage such as to justify the gradual handing over of the work to the garden owners. This will be begun next year and sprayers will be on sale generally for the first time. The Government work will be gradually restricted to further experimental work on spray materials and methods of spraying and to demonstrating the advantages of spraying in those parts where such work has not previously been done.

2. *Anaberoga of Supari.*—Work on this important disease of the areca palm has been in abeyance owing to pressure of other work. It will be resumed during the winter.

3. *Ring disease of potatoes.*—Work on this important disease has been progressing but slowly owing to inadequate staff. However, results of decided practical value have already been obtained, especially with regard to the spread of the disease and the length of time the bacteria causing it are able to remain alive in the ground. The work on this disease will be pushed during the coming winter, and it is hoped an extensive bulletin will be published on the subject before the end of 1912.

4. *Spike disease of Sandal.*—If possible, work on this disease will be resumed.

5. *Smut on Jola.*—Work on the life-history of the fungi causing smut on Jola has been commenced and will be continued. It is being carried out under the direction of Dr. Coleman, not by the regular staff, but by the Demonstrator in Botany of the Central College, Bangalore, for his Master of Arts degree.

IV.—ENTOMOLOGY.

The rice grasshopper.—The life-history of this important insect pest has been carefully worked out and investigations in the fields have been continued for three years. The results have been embodied in a bulletin which has already been published. The centres of infestation are being ascertained and demonstration work on a large scale has been carried out in one of the infested areas. This demonstration work will be extended to the other infested areas and as far as possible thorough combative campaigns will be organised.

2. *The Jola or Deccan grasshopper.*—This new pest has been the object of extended study, the results of which have already been published as a bulletin. The infested areas have been carefully gone over and combative measures on a fairly large scale are at present being carried out. This work will be continued and extended.

3. *The Kumbli Hula* (*Creatonotus albistriga*, Wlk.).—This important caterpillar pest is at present being investigated and combative measures are being tested. The results will be issued shortly as a bulletin of the Department.

4. *Ground beetles.*—The life-history of *Opatrum depressum*, one of the common ground beetles, has been worked out. This beetle has been found to be a pest of minor importance. The results of the investigations which are still being continued will be published shortly.

5. *General rearing and collecting work.*—As much time as possible is being spent on this work and a large number of rearing notes have already been gathered. These it is proposed to use later on in preparing a text-book on the insect pests of Mysore. A large number of parasites of various insect pests have been reared and about thirty of them have been sent abroad for identification.

V.—AGRICULTURAL EDUCATION.

The establishment of an agricultural college is under contemplation.

11.—BARODA STATE.

(M. A. Sitole, B.A., M.R.A.C.)

There are now three farms in the State. Baroda and Jagudan (Kadi Division) Farms serve as demonstration stations. Songadh Silk-Farm is removed to Navsari owing to the very unhealthy climate of the station. Vyara Farm is abolished, and a plot of land adjoining Baroda Farm is hired for growing castors for eri-culture. Experimental and demonstrational work on which the Department will be engaged during the years 1912-13 and 1913-14 will mainly fall under the following heads :—

I. *Varietal experiments* with tobacco, cotton, ground-nuts, potatoes, sugarcane, and wheat will be continued.

II. *Manurial experiments* with tobacco, cotton, and sugarcane will be continued.

III. *Improved implements.*—Foreign ploughs and chain pumps are in great demand. Efforts will be made to introduce them on a large scale amongst the cultivators.

IV. *Well-boring.*—Ten Cawnpore boring sets are actually engaged in boring the cultivators' wells. Orders will be given shortly, when the sanction comes, for six more sets.

V. *Publication.*—The Quarterly Magazine in Gujarati will be continued and distributed free of charge to 2,500 village boards and village libraries.

VI. *Insect and fungoid diseases* will be noted and specimens collected and forwarded for examination and identification.

VII. *Eri-culture.*—Eri-culture is being taken up in Gujarat. Efforts will be made to extend this industry.

VIII. *Distribution of seed.*—Collection and distribution of improved seed will be continued.

IX. *Agricultural shows and demonstrations* will be organised in suitable localities.

12.—KASHMIR.

I. Experimental work at the Pratap Model Farm to be continued on the following points :—

(*i*) *Varietal experiments.*—Varietal experiments with wheat, oats, barley, mustard, peas, paddy, maize, ground-nuts, beans, and tobacco to be continued as last year, and in the case of paddy, ground-nuts barley, maize, beans, which have given encouraging results so far, trials will be made on a larger scale.

(*ii*) *Cultivation experiments on paddy crops.*—Different methods of cultivation as to sowing and planting now in general use all over the valley will be compared till some definite results are obtained.

(*iii*) *Manurial experiments.*—Manurial experiments with wheat, mustard, barley, maize, juar, will be continued. Manurial experiments with paddy, tobacco, ground-nuts, and potatoes will be started. The manures to be tried in each case are those which are easily obtainable by the cultivators of the valley. Leguminous crops are also being tried as green manuring for cereals in comparison with farm yard manure. The object is to see whether green manuring can quite as well and economically serve the purpose of farm yard manure which is being preserved and applied properly. It was tried last year and gave encouraging results.

(*iv*) *Rotations.*—The experiments with Norfolk rotation of four course system, two year rotations, and *Dofasli* rotations will continue on the same lines as last year.

(*v*) *Miscellaneous crops.*—Trials of the following crops will continue :—Juar, lucerne, mangels, *arvi*, gram, potatoes, etc.

Fibre experiments with jute, sann hemp, *Hibiscus cannabinus*, Yarkand bhang, and Russian linseed will be tried again. Agave was cultivated but it proved a failure.

(*vi*) *Improved agricultural implements.*—Suitable agricultural implements are being imported and tried on the Pratap Model Farm. Their use is demonstrated to the zemindars at agricultural and cattle shows and on various occasions on the farm. Some of them are decidedly superior to, and more useful than, the ordinary village implements used for the same purpose. The trial with these and recently imported implements will continue for some period more. Simple implements will be made locally and introduced among the cultivators, etc.

II. Seed selection and distribution of ordinary crops will continue. This year selected seeds of maize, paddy, and ground-nuts have been distributed to the cultivators of the valley through the Revenue Department.

III. Insects and fungoid diseases will be noted and specimens collected and forwarded for examination and identification.

IV. *Cattle-breeding.*—Efforts will continue to improve local breed of cattle by crossing it with a Hissar bull.

V. *Agricultural and cattle show.*—An agricultural show, which was held at Srinagar during the second week of October 1909, met with considerable success. It has been decided that one show on a larger scale will be held every year in future.

VI. Organisation of the Department will continue.

VII. Introduction of European fruits and vegetables in the State gardens and the experiments with vegetables on the Pratap Model Farm will continue.

APPENDIX C.

Subject V :—Note on Fertilizers.

(A. A. Meggitt, B.Sc., Agricultural Chemist, and A. G. Birt, B.Sc., Deputy Director of Agriculture, Eastern Bengal and Assam.)

In view of the fact that the question of fertilizers may come up again at the next Board of Agriculture, and in anticipation that the subject may be fully and profitably discussed, we venture with some diffidence to put forward *a scheme of manurial policy, which we,—having regard to the whole of the conditions, economic, climatic, etc.* under which we are working, and the peculiar soil conditions with which we are confronted over large tracts of *country,—have already inaugurated in Eastern Bengal and Assam and which we think may not be without interest* to other workers. It is possible that conditions, approximating in many respects to our own, may obtain in other *parts of India, and in the hope that what promises to be a very useful,* simple and probably profitable system of manuring may perhaps be given a trial there also, we propose to describe hereafter the broad lines of our work.

In the early history of this Department many manurial experiments were inaugurated, into which the usual soluble artificials largely entered. In the result, we have come to the conclusion that, in our case at any rate, a continuance of such work is not warranted, nay more—would represent in the end wasted time, money, and energy, and point to a lack of appreciation of the true position of things in general.

In some cases the above early experiments did not take into sufficient account the conditions of the soil, or those economic and other conditions which will necessarily always govern such work when translated into the every-day action of the life of the Indian cultivator.

Soluble artificial manures, of a *forcing* character, moreover highly expensive, and capable of being abused, and for which some of us are apt to retain an affection born of earlier associations, find their proper use no doubt under some conditions, but we are personally so far convinced that the improvement of Agriculture in general in this part of the world is not to be looked for in their enhanced use, that except for very special purposes, we are almost entirely discontinuing their use.

We are turning our attention rather to more permanent methods of soil improvement, those more calculated in our opinion to keep up a healthy, vigorous soil-constitution and soil-climate, and more suited to the necessities, natural resources, and economic conditions of India and its people.

There are now on the Indian market and under trial by the Agricultural Department innumerable fertilizers of a very highly forcing character. Rightly used they are no doubt gigantic forces in the hands of an intelligent farmer, but what a fund of knowledge and experience is required in their use! We ask :—Can we expect such knowledge and experience at the hands of the general cultivators of this country ?

We have arrived at the conclusion that we should be doing wrong in advocating their extended use at the ryots' hands for several reasons, some of which are as follows :—

(1) Their excessive cost.

(2) Liability to their abuse in unskilled hands.

(3) Their unsuitability for certain large tracts by reason of the nature of the soil and climatic conditions which obtain in them.

(4) The possibility that in their extended use we may lose sight of the natural resources of the country.

1. *Cost.*—This is to our minds an absolute prohibition of their extended use by the ordinary cultivator except for very special crops. Capitalists may be able to afford them and in many cases find them profitable, but we remember that primarily we are not working for such men. We are rather concerned with the man of small capital who cultivates a few bighas or acres of land as the case may be ; a man further who is not in a position to pay fancy prices for his manure. So long as such substances as cow-dung, bones, oil-cakes, etc., are available at fair rates, we regard it as premature and probably economically unsound to attempt to push soluble artificials.

2. *Liability to abuse.*—This is a very real danger indeed ; there will be few of us who have not seen something of the effects of abuse of forcing artificials even in England.

At the hands of those familiar with manuring practice, abuse is not likely to occur ; but has the ordinary cultivator of this country the requisite knowledge to properly use them, or are we as a Department able, except on a very small scale indeed, to give that supervision which will be necessary at any rate for some time to come ?

The practicability of the subsequent adoption by the cultivator himself of manures to be experimented with by us on our farms, we now take carefully into account beforehand.

A certain familiarity on their part may already be assumed with regard to the principle of green manuring for instance, and with the use of cow-dung, bones, oil-cakes, ashes, etc., and we think that the effects of these manures on the permanent fertility of the soil are likely to be much more marked than that of soluble artificials, and the user is far less likely to go wrong in their application. The same remarks would not apply to such commodities as superphosphates, sulphate of ammonia, etc.

Nitric nitrogen is no doubt an enormous asset in the hands of an intelligent cultivator, but it is essential it be used aright, otherwise it may become a most dangerous substance. Its extended use in unintelligent hands will often mean more weakened and devitalised plants, laying them open to new diseases, or fresh biologic forms of old ones. In a climate like ours too terrific losses may occur from indiscriminate use of nitric nitrogen. Abuse of artificials may stimulate crops to such an extent that they draw very heavily on the soil, perhaps in the direction of some plant food not directly added in the manure, thus returning an apparent temporary profit in a system of ultimate land ruin.

Our forefathers had none of these highly forcing soluble artificials ; they dunged their land, they limed, they applied bones, and they thoroughly cultivated their soils, with the result that they grew good, hardy crops. To-day we have soluble manures at hand of a highly forcing character and we fear that their introduction to the cultivators might lead to the advantages of thorough cultivation, and tillage, and sound soil treatment, being lost sight of, in the possibility of being able to administer doses of quickly acting powerful medicine if things went wrong in consequence.

There is some danger, we think, *of our considering each individual and successive crop as a thing in itself*, as if nothing more is ever to follow it, rather than turning our attention to adopting such more or less permanent and rational *systems of manurial practice*, coupled with *suitable rotations*, and with strict *reference* to the idiosyncrasies of each particular type of soil, as will result in building up, by way of a sound foundation, a thoroughly healthy soil in which crops will naturally thrive well.

3. *Their unsuitability for certain large tracts owing to soil and climatic conditions.*—There are undoubtedly in this province, and probably in other parts of India too, large well-defined tracts of soils which are at the present time absolutely unfit to receive dressings of certain artificial manures, and we believe that nothing but permanent injury would result from their extended use.

That this is true of certain tracts is due to a variety of causes.

We suppose no one would dispute the point that up to the present Indian Agriculture has been extensive in character, and very wasteful in its methods. It has depended almost entirely on the natural resources of the soil, and this, combined with climatic conditions in certain parts of the country, has resulted in exhaustion more or less complete and sometimes very one-sided, leading to unhealthy soil conditions. The process is still going on ; we have in Assam for instance individual cases of fairly large areas of originally virgin forest land put under sugarcane for a number of years, with very little or absolutely no manure put into it, and with very little attempt made to keep down jungle amongst the crops, a condition of things which speedily results in more or less complete exhaustion.

The removal of countless successions of grain crops from the land coupled with the extremely meagre returns made to it in the form of manure in the past, the fact that cattle are generally very badly fed, and rarely if ever folded on the land except in the case of grazing lands, all this has culminated in the present low natural fertility of much of the soil of this country.

Unless and until such soils are thoroughly restored and revivified one cannot expect them to grow satisfactory crops, though one may in some case perhaps force a sudden result by the use of some highly forcing soluble manure. The use of such forcing and unnatural means for a more temporary advantage is not however to our mind a solution of the problem of the soil's permanent improvement. We think it is unsound economy. The above state of affairs has resulted in Eastern Bengal and Assam in large tracts of land becoming not only very deficient in certain plant foods, but the soil has arrived at a very unhealthy acid condition, a condition which prohibits healthy bacterial action, with all the resultant disadvantages appertaining to such a state of things, and also puts out of court the advantageous use of all acid or potentially acid manures such as superphosphate and the ammonia salts.

The weight of our annual rainfall, coupled with its comparatively wide distribution, also renders the use of soluble nitrates very largely out of the question. Even though by suitable soil treatment the unhealthy conditions of these soils be remedied, and the soil brought into a thoroughly healthy condition so that the above remark as to the application of certain kinds of manure no longer applies, we personally think that even then we should be adopting an unsound policy to recommend widely the use of soluble artificials, in the present state of the knowledge of the average Indian cultivator as to their use.

Moreover, we believe, in a manner that we shall presently explain, that it may be possible to achieve a sounder and larger measure of permanent fertility and at a less cost, than by the wide and extended use of soluble manures in this province. These views may not commend themselves to all who are connected with the welfare of the soil in this country, and its continued productiveness, but this does not weaken our belief in the truth of them as being part of a fundamentally sound policy.

4. *The possibility that the natural resources of the country may be partially lost sight of.*—We feel that far more is demanded of us by way of exploiting the natural resources of the country. For example, the quantity of bones annually exported from India is enormous, but the amount wasted is probably far greater. All this represents a terrible drain on the soil's resources, and we think that if we can teach or persuade the people to conserve and use their bones under proper conditions, we shall do more lasting good to the country and at a lower cost, than by encouraging the return in the form of superphosphates of the phosphoric acid annually exported in the raw form. Statistics show that during the five years 1903-1908 the materials exported from India under the head of animal bones have averaged over 82,000 tons per annum.

The large exports of oil-seeds and cakes might also be quoted.

So much by way of introduction. Reference to published analyses of the soils in general of North-East India, and our own work on some more of them, shows apparently that in the result the general run of soils are more or less deficient in phosphoric acid, organic matter, and nitrogen, while in some cases also, where rainfall is excessive, leaching has reduced the lime content to dangerous limits, and the soils have become acid in character. As regards potash, few soils are deficient ; indeed in most soils, the reserves of potash are very great and will last for generations, becoming slowly available under suitable systems of cultivation and rational soil treatment.

Furthermore, far the greater percentage of potash removals occurs in the straw and stalks of crops and we believe it is fairly general to leave a long stubble in the field, consequently the removals of this element are not commonly so heavy as those of phosphoric acid. Again the moderately dry dung of Indian lean cattle, containing, say, 20 per cent. moisture shows according to Voelcker about 1 per cent. of potash. If therefore only 50 maunds (*i.e.*, less than 2 tons) per acre be applied to the land every year it will mean an addition of potash of something of the order of 40 lbs. as K_2O.

Our object then is to introduce a systematic policy into our experimental work with a view to restoring those soil deficiencies revealed by analysis and learned from our experience.

We are assuming therefore that for those types of soil which are not acid in character, in other words those which have a sufficiency of calcium carbonate, the only constituents that must be supplied in order to permanently maintain their productive power are phosphoric acid in some form, and organic matter containing nitrogen.

Where acidity exists, *i.e.*, where the figure for calcium carbonate falls very low, the addition of lime in some form is also considered essential to correct acidity and liberate potash and otherwise permit of the soil, with its living hosts of bacteria, performing its normal functions. This is of the utmost and very first importance in such soils, and must be understood to take precedence over everything else. We have already abundant proof of the truth of this in the light of experience gained on some of the soils of Eastern Bengal and Assam during the past four years.

It is well known and generally recognised that the reaction of a soil (as to presence or absence of acidity) exercises a marked effect on its crop producing power. Broadly speaking no more striking proof of the importance of maintaining a faintly alkaline reaction of the soil is needed than is furnished by those soils that have become famous for their persistent fertility under exhaustive conditions. The "chalk" of England, the "Basaltic Soils," and in our own country the "Regur" are all soils which are recognised as being very fertile in their respective localities and have maintained their fertility for thousands of years. These soils are all more or less alkaline in reaction. The history of liming furnishes further general evidence as to the value of an alkaline reaction of the soil as one of the chief economic factors in crop production.

Other fertilizer materials have some value and sometimes great value on abnormal soils and others are powerful soil stimulants, especially on soils deficient in organic matter ; and if applied with intelligence they may sometimes be used temporarily with justification and advantage, but for the general run of soils we think they are probably often superfluous and what is more to the point they are often unprofitable in good systems of soil improvement. But in general, to very abnormal soils other than those already mentioned it must be understood that our remarks do not apply.

In tackling then the question as to the line of treatment we should adopt in our attempts to permanently improve the fertility of the soil occurring over large parts of North-Eastern India we are taking into consideration the following points amongst others :—

(1) The nature of the soil as to the presence or absence of a sufficiency of calcium carbonate.

(2) The climatic conditions of rainfall, etc.

(3) The natural resources of the district.

(4) The cost of the treatment proposed.

(5) The permanency of its effects on the general agriculture of the tract.

(6) The likelihood or otherwise of the possibility of abuse of the manures to be used, in unskilled hands.

As before mentioned, our proposals are broadly—

(a) For tracts of soil deficient in calcium carbonate and acid in character, the use of some form of lime, some form of phosphoric acid, and organic matter containing nitrogen.

(b) For soils alkaline or neutral and having a sufficiency of calcium carbonate, the addition of some form of phosphoric acid and organic matter containing nitrogen.

We next come to the consideration of the point as to what form these additions shall take, and how they shall be incorporated into practice. As to the form which the application of lime shall take where shown to be necessary, having regard to all known facts, one would unhesitatingly say ground limestone, but since this is very difficult, if not impossible, to obtain, caustic or slaked lime is being used. This will become carbonated in a short time, and will put the soil on to a fair road to recovery. Some of course may argue that the caustic lime will also burn up the soil's organic matter, but even caustic lime can be used with profit, if ample provision be made to replace the organic matter destroyed and also to restore the extra phosphoric acid which will be removed in succeeding crops, and this is all provided for in the scheme. A little loss of nitrogen and humus may occur at an early stage after applying caustic lime, but this will be amply compensated for afterwards, and once carbonated, the lime will exert only the milder action of correcting acidity and encouraging the activity of the nitrogen collecting and nitrifying organisms. Extended investigations carried out by the Pennsylvania Experiment Station (Report, 1902) demonstrate the superiority of ground limestone over caustic lime, and this is supported by other recent work in England.

The amount and frequency of application of dressings of lime in any form are matters which will vary with circumstances (and upon which we are working), for instance :—

(a) Upon the kind of lime applied, whether as fine ground limestone or caustic lime.

(b) Upon the acidity of the soil to start with.

(c) Upon the nature of the soil, i.e., whether very sandy or clayey, and the amount of organic matter contained in it.

(d) Upon the rainfall ; in districts of heavy rainfall more loss will be suffered by leaching.

(e) Upon the amounts removed by successive crops.

(f) Upon the depth of ploughing commonly practised. The action of lime does not descend much below the depth to which the soil is ploughed, and hence to put in large doses of caustic lime and plough shallow would represent an enormous dressing on the surface few inches.

(g) Upon the nature of the sub-soil. When the sub-soil is acid also, liberal application may be made and ploughing done moderately deep. In times of partial drought the acidity of the sub-soil may come up, and if there is no lime to meet it, harm will result. If, however, the sub-soil contains abundance of calcium carbonate, some calcium bicarbonate will be brought upward into the surface soil with capillary water, and may serve to reduce the acidity of the surface soil at critical times during drought. It will thus be readily conceded that in the rate and frequency of application of lime there is ample scope for enquiry and useful work.

In considering the form the application of phosphoric acid should take, the commodity that struck us first and foremost as being the most widely distributed, the most easily obtained generally, and most probably the cheapest form of this element of plant food is bones in some form. Since phosphoric acid is generally deficient in our soils, we are making it our aim to apply it in cheap form and in positively larger quantities than will be removed in large crops, and then hope to make it available by our methods of cultivation, rather than to apply it in the form of highly expensive soluble artificials which might give a bigger initial result, but which will not "wear" like bones, for instance. Phosphoric acid is a necessary addition not only to improve the stock of that element present in order to provide for removals by grain crops, but also to provide suitable food for the nodule bacteria of leguminous green manure crops, upon which we, as will be shown later, are partly relying for the supply of the organic matter and nitrogen which must generally also be added in some form.

We may be accused of working for posterity in advocating the use of bones, but is it not better, we ask, for us to begin work along what we reckon as sound economic lines now, rather than to wait until the decreasing productive power of the land coupled with increasing population brings its inevitable result ?

Besides, bones in a finely crushed form with a rational system of soil treatment, which includes green manuring at intervals, come into use fairly quickly, more quickly than some may suppose, and it is quite probable that as a consequence of the relatively high soil temperatures which obtain in India this is more so in this country than Europe. Hall (Fertilizers and Manures) states that of the phosphates in bones about one-half can be dissolved on shaking up 1 gramme of bonemeal with one litre of 1 per cent. citric acid solution, which would show that the phosphoric acid is easily available. The experimental evidence which no doubt does exist that bone meal is rather slow acting as a source of phosphoric acid arises from its comparative coarseness. We personally had recently a soil through our own hands which contained visible small pieces of bone, every bit of which dissolved out in 1 per cent. citric acid solution with 7 days' shaking. The evidence adduced up to the present as to the effect of bonemeal in this country is very incomplete. Our experience in Eastern Bengal and Assam with bones has always been very favourable, and we get an almost immediate response. The fact that bonemeal has generally given better results wherever tried by us in North-East India may no doubt be ascribed to the fact that our soils are generally speaking less deficient in organic matter than those of Peninsular India, a state of things probably due to our rainfall distribution conditions by virtue of which the surface of the land is generally covered with vegetation of sorts. This gives the clue then to one of the principal conditions of the successful use of the more insoluble forms of phosphoric acid in this country, and the inclusion of green manuring as an essential feature in the general cropping scheme, in the system of manuring under discussion will, we think, provide the organic matter necessary to make the use of what are regarded as the more insoluble forms of phosphatic fertilizers not only possible but also profitable.

Steamed bonemeal would of course be preferable to raw meal, but would cost more. Both may be regarded as absolutely safe fertilizers. They never injure the soil whatever its condition, which cannot be said of all phosphoric fertilizers.

Another substance which we intend to try as a supplier of phosphoric acid is raw mineral phosphate in a finely ground condition. This has an advantage over bones in that it runs up against no caste prejudices. Mineral phosphates have been but little used directly as manures in Europe, but there is plenty of evidence that, when finely ground and used in conjunction with organic manures, they are quite effective. According to the Quinquennial Review of Mineral Production for the years 1904-1908 there exist in the Trichinopoly District of Madras deposits of mineral phosphate showing from 56 to 59 per cent. of Tricalcic phosphate and about 16 per cent. of calcium carbonate. No information is given as to the extent of these deposits, and the present concessionaire of the beds informs us that he is not in a position to deliver ground phosphate at present, as no crushing plant has been erected owing to the small demand for mineral phosphate in this country. This is much to be deplored, as in view of a long and very complete and exhaustive series of experiments carried out in the United States it is well worth consideration, and we think it might be advisable for us as a Department to endeavour to exploit these natural phosphates. It does not follow that the phosphate beds above referred to are the only ones that exist in India. As a result of the exhaustive experiments above referred to, it is stated to be the fact that wherever fine ground natural rock phosphate has been used liberally and in connection with decaying vegetable matter, it has given satisfactory results, even during the first rotation, and with continued use it has proved to be the most economical and profitable form of phosphorus to use in permanent systems of cultivation.

In this connection it is well to remember that the phosphoric acid contained naturally in the soil is not in the form of acid phosphate but largely in the form of disintegrated rock. *And yet this material becomes available by suitable farming.* Again phosphatic marls containing phosphorus in the insoluble mineral form have been used for centuries for direct application to the soil. If raw phosphate can be obtained cheap enough and if the Indian deposits are extensive it should be economically possible to apply to the soil larger quantities of phosphoric acid than are removed in large crops and thus ensure a permanent improvement as regards the soil's stock of this plant food.

A further advantage, which raw mineral phosphate shares with bones and slag, is that it is free from acidity, and has no tendency to injure the soil in any case. For the information of those who may not have seen the report of the raw phosphate experiments above referred to we append a brief digest showing the principal features. They were commenced by the Ohio Agricultural Experiment Station in 1897, and 12 years' results are available. The soil was most deficient in phosphoric acid with nitrogen as the second limiting factor. *A three years' rotation of corn, wheat,* and clover was followed on three separate tracts of land so that each crop was represented every year. One plot in each series received 8 tons per acre of manure "taken from the open barnyard where it had been accumulating during the winter" and applied to the clover sod in the spring to be ploughed under for corn. Another plot received 8 tons per acre of manure "taken from box stalls where it had accumulated under the feet of animals kept continually in the stall." Two other plots in each series received the same kind and quantity of manure, with each ton of which was mixed 40 pounds of fine ground raw rock phosphate, and two other plots received manure with each ton of which 40 pounds of acid phosphate had been mixed. Every third plot in each tract or series received no manure or other fertilizer. The results are of great interest, and to those who wish to pursue the matter further, we recommend a study of the figures as set out in the original report of the station. As a general average of tests on all series, the raw phosphate produced practically the same gross increase as the acid phosphate, although the acid phosphate applied cost twice as much as the *raw phosphate. With double the investment the profit per acre was slightly greater* from acid phosphate, but on the basis of money invested, the profit from raw phosphate was almost double that from acid phosphate. Further using equal quantities of raw and acid phosphate respectively, the amount of phosphoric acid added by the raw phosphate was actually about double that added by the acid phosphate, so that the raw mineral enriched the soil in phosphoric acid twice as much as the acid, while the removal of crops was practically equal. This is of enormous economic importance. These Ohio investigations with raw *versus* acid phosphate are in a class by themselves. No other similar experiments have been conducted elsewhere in the world that can compare with them in agricultural value. Many experiments with raw phosphates have been carried out for a single season and some for several, but as a rule no farm manure has been used and no adequate provision made for a supply of decaying organic matter. Where nitrogen has been supplied it was in some commercial form such as sodium nitrate. Furthermore the most marked benefit from the use of raw rock phosphate has not been on markedly acid soils but on *the practically neutral silty* loams of the corn-belt of America. Two important facts are stated as established by the Ohio experiments: first, that finely ground natural rock phosphate is a material that can be employed with very large profit as a phosphatic fertilizer when used in conjunction with liberal amounts of decaying organic matter, and secondly, that under the conditions of the experiments the raw phosphate gave practically the same profit per acre, and twice as much profit for money invested, as the acid phosphate. Another series of experiments of which 11 years' results are available is reported from Maryland, in which were contrasted (1) bonemeal, (2) slag phosphate, (3) no phosphate, (4) and (5) two samples of raw mineral phosphate. Equal amounts of P_2O_5 were used in all tests. Green manuring was provided in two series out of three. As an average the raw phosphate gave nearly the same results as the bone and slag. The average increase in yield was very marked with wheat, less with hay, and practically no effect was seen on corn. The value of the total increase in 12 years was about ten times the cost of the raw phosphate. In commenting on the experiments, the Director of the station says:—"The results obtained with the insoluble phosphates have cost usually less than one-half as much as that with the soluble phosphate." "The *results show decidedly* that plants are able to utilise the insoluble rock phosphate." "*The use of an abundance of* organic matter in the soil when insoluble phosphates are applied was evidently a necessity for their best effects." The essentials in the use of raw phosphates seem to be—

(1) That the mineral be finely ground so that 90 per cent. at least will pass a sieve with 10,000 meshes per square inch.

(2) That it will not give marked benefits unless used in conjunction with adequate supplies of decaying organic matter. It has practically no value as a top dressing but must be ploughed under and thoroughly incorporated with the soil. Of course it does not act as a soil stimulant to liberate other plant food from the soil, although it sometimes contains some calcium carbonate and then has some power of correcting acidity.

As in the case of the application of lime where necessary, so in the matter of provision of phosphoric acid also, whether bones or raw phosphate be used, details as to amount and frequency of application will have to be worked out for each large tract having regard to existing agricultural practices, conditions of soil, etc., and this aspect of the question is receiving attention at our hands too.

Concerning provision in this scheme for the addition of organic matter and nitrogen, from what has gone before it appears clear to us that we must look to green manuring practices and the addition of cow-dung and other organic manures, as directly opposed to commercial forms of nitrogen such as ammonia salts, soluble nitrates, etc. Apart from their action in bringing into use the insoluble form of phosphorus advocated above, we believe no one will deny that one of the chief points on which our attention as agriculturists should focus is the permanent increase of the amount of organic matter in the soils of the country, especially in view of recent discoveries as to the relation between carbohydrate supplies to the soil and the activity of nitrogen gathering bacteria, the azotobacter, etc. It plays an enormous rôle in the soils of temperate climates, but who shall measure its importance in the soil of a tropical or semi-tropical country?

Green manuring is not by any means unknown in this part of the country, and in many parts its advantages are clearly recognised, but there is room for its far more extended use in this province, and much pioneer work is possible and demanded of us. In this connection we shall endeavour to interfere as little as possible with established agricultural practice. In some tracts it may mean the loss of one crop every few years say. In other cases we believe green manure crops can be put in, at any rate partly, as catch-crops. In the Rajshahi District of this province for instance *Lathyrus sativus* is sown broadcast over the winter paddy before the land dries up, and before the paddy is reaped. The crop grows amongst the paddy stalks and is allowed to remain after the paddy *is harvested, and although* not strictly used as a green manure crop, since it is almost invariably either taken from the land or grazed off by cattle, yet the roots and stubble form a valuable addition to the soil. Moreover since such a practice is already in vogue it should be less difficult to introduce a scheme of green manuring by catch-crops in this district. Mollison (Indian Agriculture, Volume III, page 79) states that this crop is grown as a second crop in rice fields in the Bombay Presidency and that a good crop forms a thick close mass over the whole surface. It is a hardy pulse and easily cultivated and some authorities state that it will grow successfully in soils unsuited to any other pulse. If sown on miry ground this crop is not so much injured as other crops by the subsequent hardening and cracking of the surface. When this is possible it means that no crop is lost and far less difficulty would be experienced in pushing green manures. *Even though a crop has to be occasionally* lost under this scheme, it is quite likely that by virtue of the enhanced fertility of the land the loss will be more than recouped later in bigger crops. This financial aspect of the case must be carefully worked out by us beforehand for each distinct set of conditions, and it will necessitate careful experiment for a series of years over several rotations to determine it finally and satisfactorily. In tracts with different soil and economic conditions and with widely varying cropping systems, the frequency of introducing the green crop will also vary. In some parts of the country where an early rains crop is not taken, as for instance over large tracts of Assam, the green crop may be put in then and will not mean missing a crop.

In the result, a system of manurial practice under which the organic matter and nitrogen required for the crop are obtained from the atmosphere, and the only manures to be directly added are in one case a very occasional dressing of lime, and rather more frequent dressings of, say, bonemeal, or in another case only the bonemeal at intervals, such a system should be capable of yielding large profits. The addition of nitrogenous organic matter will of course usually be augmented by dressings of cow manure which one may say, without fear of contradiction, is practically the only manure used to-day by cultivators generally and that not to such an extent and in such an economical way as it might be. It may be asked of course, *is it possible by green manuring, in addition to the use of cow manure, to keep up the soil's supply of organic matter and nitrogen, sufficient to meet the demand of the increased crops which we doubt not will accrue from the system of soil treatment advocated* ? We personally do not doubt it though the necessities of the case will obviously vary in different tracts. We hold to this opinion, while maintaining that, owing to the loss of nitrogen in drainage water and heavy oxidation of organic matter in a tropical climate, the addition of nitrogen to the soil must be in excess of the amount removed by crops if the productive power of the soil is to be maintained. This problem, *viz.*, how by such methods as above advocated to keep the supply of nitrogen (and phosphoric acid) a little in excess of crop and other removals without unduly interfering with the established cropping practices, is, we maintain, one of as nice and thoroughly practical problems as ever engaged the attention of soil workers and one which we of this Department are now tackling.

Centring our attention on the nitrogen problem, it is common knowledge that certain crops remove more than others. A 50 bushel crop of wheat will remove some 100 lbs. of nitrogen in grain and straw, opposed to a maximum removal of only some 25 to 30 lbs. nitrogen in the case of a very excellent *aus* paddy crop in Eastern Bengal. Let us consider then a specific rotation including one green manure legume crop and see how far the nitrogen it supplies will meet requirements. *In putting forward the following, we do not indicate it as even a desirable rotation in any way nor is it one we have adopted, it is merely by way of illustration* :—

1st year	Rains crop	Green legume to be ploughed in.
	Rabi crop	Mustard.
2nd „	Rains crop	*Aus* paddy.
	Rabi crop	Oats.

In calculating removals of nitrogen by the mustard, *aus* paddy, and oats, we have taken what we consider to be good average crops of each and have assigned generally a higher nitrogen value than would appear to be correct from analyses made by Leather and Collins and quoted in Mollison's Indian Agriculture.

Crop.	Yield per acre.	Per cent. of nitrogen.	Removals of nitrogen per acre.
		Per cent.	
Mustard	Grain 500 lbs.	2·7	14 lbs. say.
	Straw 1,600 „	0·25	4 „ „
Oats	Grain 1,200 „	1·8	22 „ „
	Straw 2,000 „	0·25	5 „ „
Aus paddy	Grain 2,000 „	1·0	20 „ „
	Straw 2,400 „	0·3	7 „ „
	Total crop removals of nitrogen		72 lbs. say.

To this must be added a certain amount of nitrogen for removal by drainage. This loss will admittedly vary over different tracts of country where soil and rainfall conditions are widely different, and different systems of cropping and soil treatment are in vogue, and one cannot even hazard a guess at what it may amount to, but suppose we put it at about 30 lbs. of nitrogen per acre per annum for a district where the annual rainfall is of the order of 70 inches. Assuming a mean annual drainage equal to half the fall, *viz.*, 35 inches, and making use of European figures for composition of drainage water from plots to which soluble nitrogenous and mineral manures are not supplied, we arrive at a figure of the order of 30 lbs. nitrogen per acre per annum as loss in drainage water. We do not consider it will be a heavier loss than this, considering the facts that the green crop will usually be ploughed in well towards the end of the rains, and the cow manure will more generally than not be applied to the cold weather crops when rainfall is very slight. On the above assumption there will be a total loss of nitrogen to the soil over the two years of about 130 lbs. per acre. The question is, "can this amount be supplied by the green manure crop?" That will depend upon the kind of green crop grown, the extent and condition of its growth, etc. We have produced on the Dacca Farm a green crop of *dhaincha* (*Sesbanea aculeata*), supplying at the rate of some 14 tons green matter per acre, containing over 3 tons dry organic matter and just over 100 lbs. of nitrogen and this without special treatment of any sort. We anticipate that as our soil becomes healthier we can count on even better figures. From the best experimental data available probably about ⅔ of the total nitrogen contained in a green legume crop is taken from the air. The crop of *dhaincha* referred to above supplying some 105 lbs. nitrogen per acre may therefore be supposed to have taken some 70 lbs. nitrogen from the air, the rest from the soil. The net gain to the soil then from the crop is only some 70 lbs. nitrogen which just balances the removals by the three following crops in the above imaginary rotation. We reckon that the removals by drainage which we have put down at 30 lbs. per annum will be more than balanced by the amount of cow manure applied. Suppose we allow 100 mds. per annum per acre of cow manure, and at least in this part of the country we do not think this is in excess of the average used by cultivators, that is where they use it at all. Judging from the figures quoted by Mollison and from our own experience, we shall be below the mark in assigning a nitrogen value of 0·5 per cent. to cow manure as usually produced in India. This will add some 40 lbs. of nitrogen per annum and the balance sheet works out as follows on the above assumptions :—

Soil's nitrogen account.

Dr.		Cr.	
To Green crop nitrogen obtained from air.	70 lbs. nitrogen.	By Crop removals	70 lbs. nitrogen.
To Cow manure	80 lbs. nitrogen.	By Drainage removals	60 lbs.
		Balance	20 lbs. nitrogen.
	150 lbs.		150 lbs.

This leaves us a balance of 20 lbs. nitrogen on our two years' working on the above suppositions.

The position of affairs will be still better if in place of, say, the oats in the above rotation a legume were introduced such as *Matikalai* for instance, a crop commonly grown in the Dacca District in the cold weather. For in this case if ⅓ of the nitrogen of the entire plant is in the roots and stubble, and ⅔ in the part of the crop removed, the soil will suffer no loss of nitrogen, having only supplied as much to the crop as has been left in roots and stubble. So that with some systems of cropping the frequency of the occurrence of the green manure legume crop in rotation could be reduced. But of course other considerations already sufficiently indicated have to be taken into account in finally settling that point. We remember that it is the active decay of comparatively fresh organic matter in a soil that puts life into it as opposed to the mere presence and slow decay of old organic residues that persist in many soils and give to the figure for organic carbon a fictitious value. In the balance sheet of nitrogen above no account has been taken of possible additions to the soil's stock of that element by the group of bacteria known as the azotobacter, so that the resultant balance may even be better than as shown.

We think then we have stated a case which may be worthy of some consideration as being an attempt to formulate a practical scheme of gradually and permanently building up and restoring to healthy vigorous condition large areas of land which to-day are not producing either the quality or quantity of food materials that they should do.

At any rate the results of our previous work into which soluble artificials entered largely, obtained by us as a Department up to the present, have not been attended with that measure of success hoped for, and this clearly warrants a change of policy or at least trial of other manurial methods on our part. Though opposed to attempts to put artificials of a highly stimulating character into the hands of the ryots for the reasons stated, it was with no intention of writing a diatribe against artificials purely as such, that we set out. Not at all: we recognise their value for special purposes, and for certain investigations where they must often be used, for instance by investigators themselves on experimental farms. Their use is very often necessary in settling the preliminary points of an enquiry or for acquiring merely academical information required in connection with other problems; and we recognise that the acquisition of academical information is not to be sneered at; far from it. On the contrary it very often opens up new lines of work, or leads to a better and fuller understanding of cognate matter improperly understood before.

Again on other tracts of land in India and for some crops, profitable use may no doubt be found for them.

Agricultural problems may be attacked from two different points of view :—

The Economic, in which the object is to show how crops may be produced a little more cheaply than at present.

The Scientific, the problem being investigated for the sake of the general principles it may bring out.

In our own case, we do not consider that economic ends will be best served by attempting to push soluble forcing artificials, and we think we are right at present at any rate in placing the economic aspect in front of the purely scientific, though the latter too is receiving attention concurrently with the former.

For intensive cultural work, such as obtains in market gardening operations, soluble artificials will one day tak their proper and well deserved place.

The scheme intended to be more or less permanent briefly sketched out in this paper presents a number of practical problems worthy of our steel—moreover interesting problems, and what may prove in their determination very valuable ones—and it is purely in a sound recognition of the fact that we are but a unit of a much larger body in India from which we may hope at all times to draw inspiration and help and which perchance we may even sometimes hope to assist, that we present our ideas in this form for the consideration of and perhaps trial by workers in other parts of India. Though it may fail to achieve all we hope for it at our hands, it does not follow that such would be the case in other parts of the country with varying conditions of soil, climate, agricultural practice, cropping, etc. We are disposed to think that work on some such lines affords a fine field for co-operative effort amongst Chemists, Botanists, and Agriculturists. A similar scheme worked out by Professor Hopkins in the United States (referred to presently) has given excellent results in practice on some of the worn out wheat lands of the West, and is it not at least possible that it would be equally successful on the wheat-growing belts of India ?

Clearly, much depends upon finding green legume crops suited to each tract to supply the most expensive element nitrogen, the one most readily lost, with all the one most largely removed in crops. But as insisted on before where they do not exist already, the essentially important thing is to establish sound healthy soil conditions, and this is intimately connected with the proportion of calcium carbonate present.

(We have succeeded in growing 8 to 12-anna cold weather crops on some of the worn out lands of Assam merely by application of lime alone, whereas they would not grow at all before.)

Very accurate methods for the determination of carbonate of lime in the soil exist, but any further method which will assist us in determining the reaction of soils and their lime requirements should be of the utmost value. In this connection field work, now being carried out by us on some of the acid soils of Eastern Bengal and Assam, points to a fairly close agreement between the results of that field work and results for soil reaction and its lime requirements as obtained in the laboratory by Veitch's lime water method. The method promises to be of great assistance. We hope, however, to publish further information on this point at a later date, as more results are available.

The essential features of the system outlined may be stated briefly as :—

(1) Simplicity. Few manures are to be used and at interval only.

(2) No soluble forcing artificials to cause injury to the soil or to be abused in unskilled hands.

(3) Permanent enrichment of the soil as opposed to mere temporary stimulation.

It would be of interest and value to know how the cost of mineral phosphate imported from, say, Algeria or Tunis into India would compare with that of, say, Basic slag and various kinds of superphosphates, reckoned as per pound of phosphoric acid.

Since experiments were started on the foregoing definite lines on the Dacca and Jorhat Farms in this province at the commencement of the present year, after a good deal of preliminary work and many observations on these soils during the preceding three years to determine the nature, reaction, lime and phosphoric acid requirements, and the suitability of certain green legume crop to supply the nitrogen requirements of a rotation of the ordinary cropping of the tracts represented in either case, information has come to hand of a similar scheme of work being actively propagated and strongly advocated by Professor Hopkins of the University of Illinois with excellent results in practice.

To a perusal of a very recent account of this work we are indebted for much valuable information and assistance for the future conduct of our work.

APPENDIX D.

Subject IX:—Notes on the Agricultural Associations in Provinces.

UNITED PROVINCES.

(W. H. MORELAND, C.I.E., I.C.S., DIRECTOR OF AGRICULTURE.)

The following paragraphs from the latest report of the Department summarize the present position :—

"During the Agricultural Conference the opinion was expressed by many speakers that the formation of agricultural associations was one of the greatest needs of the province, but much misconception is still prevalent as to the conditions required for their successful working. The tendency still is to form Associations without a sufficient proportion of working members or in the alternative without a paid executive, and the inevitable result is a certain amount of talk and writing but very little practical benefit either to the members or to their tenants. The conception of an association as a body of working members must become familiar to the public before much progress can be expected in this direction. At the same time there are signs in the particulars given below that a few genuine associations are coming into existence, and doubtless their practical success will lead to an increase in the number.

"In the Central Circle the Porter Association (Allahabad) held no meetings during the year, but its members rendered considerable assistance in connection with the Exhibition. The Mainpuri Association has been active and about 40 of its members are taking part in practical demonstrations of new crops or varieties, the use of iron ploughs, and improved method of maize-cultivation. This association has also interested itself in the capture of the destructive wild cattle in its vicinity, and has distributed the animals captured among its members. The Gauria Kalan Co-operative Bank in Unao continues its interest in agricultural improvement; it maintains a useful sub-centre for implements, owns a set of boring tools for its members' use, and has bought a large quantity of ground-nut seed in order to introduce the crop; it also held an agricultural show and a cattle-fair at which a brisk business was done. Three small associations have recently been formed in the Safipur tahsil of this district, composed mainly of members of three local Co-operative Societies: they are practically off-shoots from the Gauria Kalan Bank, and their activities will be watched with interest.

"No particulars have reached me regarding the activities of the Associations in the Western circle, to which reference was made in last year's report. A new association has been formed at Baraut in the Meerut District, but in this case, too, no detailed information has reached me. In the Eastern circle, an association has been formed at Walipur in the Sultanpur District. It has made a promising start, but it is too soon to pronounce an opinion as to its ultimate utility."

2. It will be seen that these bodies are not yet of substantial value. Two or three are doing a certain amount of useful work, but it remains to see whether their energy will be sustained. It is the duty of the Circle Officer to keep in touch with these associations, either personally or through a member of his staff: there is not as yet any definite organisation for this purpose as the time has not come for organising.

3. The extracts given show that the most hopeful sign is the activity of the co-operative organisation, whether a bank acts as such or whether its members form an association. It has all along been obvious that a co-operative organisation, if successful in its primary objects, would be much the most effective channel of communication between the Department and individual cultivators; but patience has been necessary, if the organisation was not to be overweighed at the start. Much of the work of the past six years has therefore been devoted to preparation for the time when the organisation would be ready to act. This time has now come: the Registrar has recently supplied me with a list extending to 22 out of the 48 districts in the provinces where the co-operative organisation is ready to enter into relations with the Department, and Circle Officers have been instructed to take the necessary steps to find out the direction in which each bank or society can best be assisted and to render the assistance required. Arrangements have also been made under which the Registrar will enable the Department to keep this list up to date by intimating periodically the additions which can be made.

BOMBAY.

(G. F. KEATINGE, I.C.S., DIRECTOR OF AGRICULTURE.)

There are 36 Agricultural Associations in this Presidency. They are not connected with Co-operative Credit Societies. Most of them owe their origin to the efforts of some individual who takes an interest in agriculture and is anxious to be helpful in the matter of agricultural improvement; and the tendency is for the work of each association to represent the activities and energy of the individual who has organised it rather than the collective energy of the association as a whole.

The Agricultural Department supplies to these associations the publications which it issues, and members of the Department visit them as often as is practicable. In this way they serve as a link between the Department and the cultivators and tend to stimulate and keep alive interest in agricultural progress. Some associations have, with the help of the Department, undertaken experiments with fair success, others have acted as agents for the supply of implements, such as iron ploughs, which is a very useful work, many have organised shows, which have certainly produced some results and have involved much labour and some expense to the organisers. It is not possible to point to very striking results, but on the whole I am satisfied with the progress made in this direction, and think that with continued attention and fostering care some of the associations will develop into useful bodies.

Two difficulties are prominent—

(1) The difficulty of sustaining the interest and continuity of work.

(2) The difficulty of providing funds.

To overcome the first difficulty I think that each association ought to have a paid man to act as Organiser and Secretary. He need not be a highly paid man, but should be a cultivator and able to read and write the vernacular. It should be his business to keep in constant touch with the Department and to organise profitable lines of development for his association.

The second difficulty can, I think, be overcome in the long run by grafting Co-operative Credit Societies on to agricultural associations. I notice that in France the terms 'Agricultural Association' and 'Co-operative Credit Association' appear to be alternatives for the same thing, and that every Agricultural Association is a Co-operative Credit Society and *vice versâ*. I should like to see the same thing take place in this country. I know of no other way in which the financial difficulty can be satisfactorily overcome; and without funds no association can do much.

A word must be said about the Deccan Agricultural Association which acts as a Central Association. It has collected fair funds and has some Rs. 7,000 invested, and obtains a good many annual subscriptions. Part of its funds are invested in Co-operative Credit Societies. It holds quarterly meetings at which papers on agricultural matters of interest are read and discussed. It runs a Vernacular Agricultural Journal which has obtained a circulation of about 3,000. It has appointed a number of sub-committees to consider special subjects, and is endeavouring to affiliate other associations with it. From the nature of its position as a Central Association it cannot well interest itself with the details of cultivation in any particular place, but it has been instrumental in undertaking some seed distribution, and some of its members have taken a keen interest in assisting in the movements of agricultural progress and co-operative credit.

I think that there is a good field for the work of such Central Associations—

(1) In stimulating the smaller associations into activity in connection with which a paid organiser is required, or, in the alternative, the Central association might help the smaller Associations with funds to pay for organisers of their own.

(2) In acting as agents for the supply of implements, manure, and seed.

(3) In organising and, if necessary, in promoting companies for the development of large schemes, such as steam ploughing or providing an adequate reserve of fodder for tracts subject to famine.

Here again the question of funds arises. The association must have an income from its invested funds and annual subscriptions sufficient to pay for its general organisation; and for undertaking definite large schemes involving the outlay of considerable capital it must raise the funds by promoting joint-stock companies or Co-operative Credit Associations, either amongst its own members or amongst the public, for specific purposes.

CENTRAL PROVINCES AND BERAR.

(C. E. Low, C.I.E., I.C.S., Director of Agriculture.)

I have been asked to write a paper on Agricultural Associations generally, but perhaps it would be better if I confined myself to a description of the lines on which these associations have developed in this province, and our present policy and anticipations regarding them. I may state that circumstances have placed me in a particularly favourable position for forming an unprejudiced view regarding their work, since this is the third time that I have held charge of the Provincial Department at considerable intervals; this makes it easier to estimate the extent to which the different features of departmental work have developed even better than if I had held continuous charge; while I have been a District Officer for some five out of the nine years during which these Associations have been working, and have therefore had the opportunity of seeing something of them from the administrative as well as from the departmental point of view.

The foundation of Agricultural Associations in the Central Provinces dates from 1902, and, like many of the most successful features of our work, is due to Mr. Sly. The lines laid down by him, which have, so far as their broad features are concerned, been followed ever since, may be seen from the following extracts from his circular letter initiating the Association:—

"A commencement has recently been made with the work, to be carried out by the Department of Agriculture in the districts of the Central Provinces, of enquiry into, and experiment with, the local agricultural conditions with the object of introducing improved methods of cultivation, improved and new varieties of crops, remedies for plant diseases and such like agricultural work. One of the best methods of securing this object seems to be the formation of District Agricultural and Industrial Associations.

2. "The main object of each District Association will be the agricultural and industrial improvement of the district. Its advice will be taken in framing a programme of experimental work and the most practical way of carrying it out. The members will be asked to visit any demonstration farms established in the district and to watch the results of experimental work in progress, giving their advice and co-operation in these efforts towards improvement. They will be encouraged themselves to undertake experiments of a simple nature, which they can carry out in their own farms and in their own villages. General meetings will be held at any convenient centre, such as the head-quarters of the district, the site of a demonstration farm, a local agricultural fair or the like. The agenda paper for each meeting should be settled by the President. The members will discuss any experimental work in progress and make recommendations for the future; some may be induced to suggest subjects for discussion and to read papers prepared by them upon any subject within the sphere of duty of the association; the Hindi Agricultural Gazette may be referred to and members asked to give their experience of the trial of any of the improvements recommended in the articles. Such meetings should not be so numerous as to become a burden upon the rural members.

3. "As regards the constitution of such Associations, it is essential that the Deputy Commissioner should be the President. Its success will largely depend upon the personal interest taken by him in its work and the encouragement given by him to its members. The Superintendent of Land Records should be a member, because he is closely connected with the agriculture of the district. All tahsildars should also be members, for they are in constant and close touch with the agriculturists, visiting them in their villages where they can inspect any experimental work in progress. The Settlement Officer, if any, should of course be a member. Unless there is any other Government officer who takes a keen interest in the work of the Association, this would seem a sufficiently large official element. The remaining members should consist of non-official gentlemen who take a keen, intelligent and practical interest in agricultural and industrial development, and who are prepared to do real work for the Association."

The chief faults that were peculiar to these societies in the early stage of their development were the following:— Owing to the insufficient staffing of the Department in its early days, when the Director was burdened with the heavy charges of Settlement and Land Records, and to the practical absence of an expert staff, it was impossible to arrange for more than a very limited proportion of these meetings being held under expert supervision. The result of such meetings where local cultivators were left to their own devices, with perhaps the guidance, zealous but unskilled, of the Collector, or of some member of his staff, was largely negative; the members were asked to recite the results of experimental growings of a large number of crops, each on a very small scale, in a way that at times reminded one more of the parable of the ten talents than of an agricultural meeting. Yet all the same, good was being done. A sense of solidarity of the interests of cultivators, and an awakening of the attention of Government officers to the details of local agriculture was brought about, which was of the greatest assistance, when the enlightened policy of Lord Curzon

provided us with an expert staff, and enabled us to initiate a programme of real agricultural work. Too much general discussion even on agricultural subjects, too much talking off the point, and too much of the darbar element characterised these early efforts. Some trace of the latter weaknesses still adheres to too many of our District Associations, but we know now how to avoid at any rate the evil of undue generalisation. It is admitted now that the best work is accomplished and the most interest elicited among the right class, if the attention of the association is severely restricted to a few subjects of actual local importance. It is idle to read papers on the advantages of irrigation in one of our western cotton districts, and it is of little more good to talk about the use of calcium cyanide, for instance, in any of our districts. The local cultivators gape in wonderment at what it all means, or perhaps one of them possessed of more tact than the rest gets up and says something about the blessings of the British Government. But if the discussion at the meeting of one of four northern associations turns on the advantages of pure wheat seed, or in one of our rice districts various members are called upon to get up and state what the yield was from transplantation by single seedlings compared to that from broadcast rice sowing, you soon see a very different state of affairs. The Chairman finds, like Hiawatha, fifty eager eyes glaring at him, and one man after another starts up, and in accents that betray his unfamiliarity with public speaking, spells out from a dirty piece of paper, drawn from some mysterious recesses of his garments, details of dates of sowing, harvesting and yield in *khandis*, of the various crops. I have seen two leading cultivators nearly come to blows over a question regarding the best manner of pitting manure, though the very same men, or at any rate men of the same class in the same neighbourhood, met my persuasions on the same point, when in charge of the district as Collector a few years before, with most polite indifference. At a well managed association one meets quite a different type of man to the ordinary *darbari* or *mulakhati*. Men quite unknown previously in any public capacity, except by some District Officer unusually well acquainted with his district, who would say "so and so is a very good landlord, and seems a prosperous quiet sort of fellow," are now much in evidence, are listened to with attention, and come up to receive *sanads* or medals for specially good work.

I may be pardoned if this discussion has dwelt too much on the spectacular side of the associations. It is the side that a visitor to the meetings would see first, and is an infallible index to their success or failure.

Speaking generally, then the keynote of our policy is that the subjects that the members are set to deal with, whether at the meeting or in their own villages, must be those in which the cultivators of the tract are directly and personally interested.

And this brings me to a further point. The smaller the unit of area, the more possible it is to particularise. The larger the area is, the more generalised are the subjects. The keenest society we have is undoubtedly a Tahsil or Taluk Association, that of Seoni Malwa. This society, among other good features of its work, has organised a successful scheme for the destruction of pig, which has been prescribed by the local administration for general adoption. So far as I am aware, the idea was entirely the members' own. They were tired of the pig eating their crops; they found themselves organised into a body, and they took advantage of the new facilities of organisation to do what they had never found it possible to do before.

This brings me, naturally enough, to the part the associations play in our departmental organisation. They are concerned, I have shown, with the problems most local in their import, and so is our Department. Whatever the Deputy Director is demonstrating in the local area the association is discussing at its meetings and practising in its villages.

And further, the primary agricultural education we are now giving at Raipur and Hoshangabad to farm bailiffs, cultivators and others—men as a rule literate or barely literate in vernacular only—is concerned solely with those particular local problems. We get as many genuine students as we can manage under these conditions, eager to practise what they have learned on their own farms, whereas our first attempt at primary agricultural education on general lines (Nagpur Malguzari class) has proved a failure.

Mr. Evans had started the practice of sowing kharif in lines a year or two ago in the Patan area of the Jubbulpore District. This is a matter of no interest to any other part of the district except the Patan area, which is hardly as large even as a whole tahsil. It succeeded, and now the Patan people are anxious to have a sub-association of their own, to help them to push this very question of line-sowing, together with one or two matters of minor importance. This perhaps is carrying decentralisation to extremes, and we are after all limited very practically by the exigencies of staff. But it will at any rate serve to point my argument, which is that the work of the associations must follow the lead of the Department and its experts. Again take one of Mr Clouston's cotton districts. Here the associations are very active: each district has its Agricultural Assistant, who is supervising ten or a dozen private cotton seed farms, all run by members of the Association. These Assistants also give demonstrations in one or two other subjects of less importance and keep in touch with the members between the meetings. When the association meets the two most important pieces of business are, probably how much seed the Akola Farm has to spare for each of the seed farm owners, when they are to write for and how to take delivery of it, and at the next meeting, what are the departmental arrangements for marketing long staple cotton, or ginning cotton for seed. Looked at from one point of view the members are unpaid officers of the Department, from another, the Agricultural Assistants are the servants of the Association. To keep the association's programme on practical lines, it is necessary that every meeting should be attended by a responsible member of the expert staff. As in all other problems of Indian administration, it is foolish to suppose that however one may welcome the signs of some attempt at real self-governement it is possible to leave this germ to develop as it will. It wants constant and careful supervision, for many years to come. Many of the monstrous growths that have disfigured the history of the past few years are due to a neglect of that principle. But there is little fear of Deputy Directors or their staff failing to put in an appearance at meetings. They are too much indebted to the members, for information of local conditions and assistance in their work, to be able to do without them. In a word, the current of work has begun to flow to a large extent through the channels of these associations, and if it were suddenly prevented by any cause from doing so, the expert staff would find their usefulness impaired and their work crippled to a fatal extent.

It is tempting to turn aside and enlarge for a few moments on the effect of the associations on the people at large; to tell how one association turned out a member for rackrenting, how another will not admit a landlord who has not embanked a substantial proportion of his wheat land, how a third have started of their own accord an annual subscription for their own purposes, but I think I have already said enough to prove the real vitality of these bodies, and their intimate connection with the agriculture of the country on the one side, and with the Department on the other. And yet I wonder if it will arouse suspicion of any interest if I say that the success of an association depends primarily on the interest taken in it by the members of the district staff, especially by the Collector. For such is the case. A continual effort is needed to keep up these institutions, full though they are of the germs of true vitality, and will be needed for years to come, and the help of the district staff is especially necessary. The local officers preside at the meetings, they select the members, with the help of the Deputy Director, they can do much, especially when on tour, to make the members feel that they belong to a body that is doing useful and appreciated work, and that they gain the respect and gratitude of Government by doing so. This is the unanimous experience of all members of our Provincial Department, and it would not be necessary in a paper intended for perusal locally to enlarge on this point. Any local officer who had studied the question could point to a dozen instances of proof, either negative or positive. For obvious reasons I must refrain from quoting these. But in spite of the great assistance that associations derive from the help of local officers, I must repeat that they contain within themselves all the elements of vitality, and are very far from being merely *darbars*.

I now pass to the discussion of a few miscellaneous points. Undoubtedly the curse of these associations is the presence of members who are in no way interested in agriculture, but are very fond of appearing in public and making speeches. I allude especially to members of the legal profession. They cut in most cases about as good a figure at these meetings as the agricultural members do when they attempt to conduct their own law cases in person. There are just one or two examples of lawyers who are really useful members of agricultural associations, but, speaking generally, it is a good rule for every man to stick to his own business. They are prone to waste the time of the meeting by making speeches on very general subjects which even our experts are perhaps hardly competent to speak

on; they carefully avoid really practical questions, on which they know the local farmers are experts and would quickly see through them and laugh at them. A long speech from a pleader, knowing nothing of chemistry, let alone of agricultural chemistry or bacteriology, proposing that Government should do all its revenue assessment by soil analysis, is a strain on the patience of the listeners, and serves no useful purpose whatever. For this reason, the programme requires a careful editing beforehand and the Chairman should take a free hand in keeping speekers to the point.

It is sometimes an awkward matter, when a District Association has become full of such members, to know what to do. To turn them out would do more good than harm, and as they tend, like bad money, to drive the good out of circulation, something has to be done, or things go from bad to worse. In such cases it is sometimes possible to split up the associations into Tahsil Associations, holding their meetings away from head-quarters.

It is highly desirable, when possible, to hold the meetings of the associations on the nearest Government farm, when the morning can be spent in seeing the work of the farm and the subject illustrated there can be discussed in the afternoon. A small museum attached to the farm, where stock exhibits, which can also be taken about to local fairs, can be seen, is a help on such occasions.

One of the weak points of all unofficial bodies is the lack of an office staff, and the appointment of clerks and peons at the present stage of the career of these bodies should be resisted unto the death. Unpaid Secretaries are apt to be a bit slack at critical moments, and it is an ungracious task to criticise their shortcomings. It is often possible in such cases to appoint the Agricultural Assistant, where there is one more or less permanently attached to the district, either as sole or joint Secretary, with the help of an unpaid member. This is the policy that it is proposed to follow in this province.

The meetings of the associations are reported in the Agricultural Gazette, and papers therein are often alluded to at meetings, while members not infrequently contribute papers and articles.

It is proposed to take the members of associations where possible on short excursions to other districts, to see Government farms, or superior local methods. For instance, a trip of members of the Patan tract to Nimar, where kharif cultivation in lines is regularly practised, is part of Mr. Evans' programme. As part of the policy of showing honour to members for useful work done, *sanads* and medals are distributed, at Divisional meetings, which are designedly more of the darbar type, but are only held at infrequent intervals. Government have on more than one occasion seen fit to mark their appreciation of good work by conferring titles on members.

Perhaps it may be of interest, if I briefly recapitulate what are the principal lines of work other than those already mentioned, that associations have successfully taken up in these provinces. The members in a large number of districts keep private seed farms, and compare notes at the meetings regarding their success. In Chhattisgarh they assist by example and by making known their results in the spread of the practice of transplanting rice. In Buldana they subsidise fairs; in Khandwa they have a small farm owned by one of their members, where they grow the leading types of pure cotton varieties; I would not be understood as approving the pernicious practice of allowing associations to manage experimental farms, which seems to me a mere waste of money. In Berar, several of the members act as agents for the sale of types of machinery recommended by the Department, thus pushing sales and saving the Department the trouble of stocking. Generally, the members may be regarded as helping to teach the people what they themselves have learned from the experts, and where the latter have successfully cultivated friendly relations with them, members are ready to help them in any way within their power.

I quote from the last report by the Commissioner on the Land Revenue administration of the Berar Division.

"It is satisfactory to record that all open manifestations of disaffection against the Government ceased.

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> The work of the Agricultural Department in particular is reported to have a marked moral effect. The District Agricultural Associations are popular and have done some real work; the use of iron ploughs is steadily increasing, there is a demand for improved seed, and *buri* cotton has been tried on a considerable scale. The efforts made by Government for agricultural improvement, particularly the work of the Akola Experimental Farm, have sensibly affected the attitude of cultivators towards Government.

I will now conclude by saying a few words about the administrative and political aspect of the associations. I do not think any department, technical or otherwise, can ignore its duty towards the general government of the country in this respect, and any member of such a department who thinks, so long as he merely carries out his technical duties, without making any attempt to attract and secure the loyalty of the people, and show them the debt that they owe to Government, is a shirker of his duty, while a man who attempts to dissociate his department from the general government of the country and poses as an outside critic of it is something a good deal worse. Neither the Department nor the Provincial Government can afford to ignore the possibilities of these associations, not only in the future, but even to some extent in the actual present, as instruments, whether for good or evil, in affecting the disposition of the people towards the Government. There are few Departments whose work is so obviously designed purely for the public good as that to which I have the honour now to belong, and it should be the duty of all its members whenever they are brought into contact with the public, to lose no opportunity that naturally arises of clearing up genuine misunderstandings and of combating misrepresentations of the attitude of Government. Association meetings should not be allowed to degenerate into academic debates, with a flavour of ill-natured criticism of Government action. And the participation of District Officers in these meetings is the best guarantee against any possibilities of this sort.

EASTERN BENGAL AND ASSAM.

(S. G. Hart, I.C.S., Director of Agriculture.)

The policy of the Agricultural Department in Eastern Bengal and Assam is to work through associates. The end kept in view is that when in any district a number of associates have taken up individual lines of work, they should combine into an association for mutual discussion and encouragement. Hitherto owing to paucity of supervising staff the number of associates is too small to permit of this object being brought into effect. The few agricultural associations which existed before the formation of this Department have been helped and encouraged in every way possible, but we find that they are chiefly composed of men who take no practical interest in agriculture. There are never more than one or two members who actually do anything to promote agricultural development. In the first enthusiasm meetings are largely attended and much eloquence is displayed; but soon it becomes difficult to induce the members even to attend a meeting and the association ceases to exist except in name. The kind of association towards which we are working will be a band of workers rather than a society of talkers.

MADRAS.

(G. A. D. Stuart, I.C.S., Director of Agriculture.)

The history of Agricultural Associations in the Madras Presidency has been mainly a record of failure. A movement, directed from above, for the formation of associations commenced about six years ago. In response to this

a number of District and Branch Associations were formed, and a Central Agricultural Committee constituted to assist and advise the associations. The statement at the end of this note gives the date of formation and subsequent history of all associations for which information is available.

2. A financial crisis in the affairs of the Central Agricultural Committee bringing matters to a head, the late Director of Agriculture, Mr. M. E. Couchman, I.C.S., addressed a letter in April 1910 to all Collectors, pointing out "that nearly all the District and Branch Associations were in a moribund condition, and that it was quite clear that they must all be wound up very shortly for want of funds if no means could be devised for awakening the interest of the actual cultivators and land-owners in the work," and suggesting that "the only feasible method of making these associations into useful living bodies seemed to lie in reconstituting them, and admitting only a small number of members who had a real knowledge of the subject," and that an attempt should be made to dispense with subscriptions as was done in the Central Provinces.

The replies received to this reference showed that there was "an irresistible concensus of opinion that the present Agricultural Associations, forced as they were upon the districts from above, representing no spontaneous movement among the cultivators, and filling no felt need, are and have been, from the first, a failure. The only apparent exceptions are some of the West Coast Associations, and here the work has really been done by the Revenue Officers. The solitary exception is the Kumbakonam Association, which has been kept going by two retired Government officials, Diwan Bahadur R. Ragunatha Rao, C.S.I., and M. R. Ry. V. K. Ramanujachari, retired Secretary to the Board of Revenue, with such help as the present Honorary Secretary, a busy Vakil, can spare from his business. Some of the Collectors think that small village associations might succeed. There is not one except on the West Coast who sees any use in continuing the present District Associations. The Collector of Trichinopoly agrees with Mr. Sampson that the associations derive no benefit from their connection with the Central Agricultural Committee and should be disaffiliated, the supervision of the work of the Associations being left to the Agricultural Department.

Mr. Couchman further noted concerning the Central Agricultural Committee that "a perusal of the quarterly reports of the Central Agricultural Committee from its foundation shows that no real work has been done by it from the first. A voluminous correspondence has been carried on with the associations, but this has resulted in no real work being done by the associations. After assuming charge of the Central Agricultural Committee, I stopped the importation and distribution of exotic seeds such as caravonica cotton, and pressed upon the associaions the necessity of confining themselves to demonstration of improvements recommended by the Department. Detailed suggestions for work were made to the associations again and again. I also made several fruitless efforts to get the members of the Central Agricultural Committee themselves to undertake some useful work on their own lands, offering them all every possible help from the Department. No response was made to these appeals. As there is no prospect of the Central Agricultural Committee either getting any work done by the District Associations or of doing any itself, I agree with Messrs. Sampson and Young that the supervision of the work of such associations, as may survive reconstitution, may be left to the Agricultural Department and the present associations and the Central Agricultural Committee itself may be wound up. In the case of those Associations which have funds at their disposal the Deputy Directors may be consulted as to the best use which can be made of these, for the improvement of the local agriculture."

Mr. Couchman then wrote the following note, in November 1910, reviewing the past history of the Agricultural Associations and suggesting the lines on which they should be reformed. "Reviewing the history of the last five years, it becomes clear that the formation of District Associations and of the Central Agricultural Committee itself was permature, and founded on several misconceptions. It was premature, because there was no spontaneous demand for agricultural associations, and the work of experiment and research, which must precede all definite recommondations, had hardly been begun. The radical error was in assuming that associations composed of Government officials, lawyers and journalists, could advise practical agriculturists in regard to their own profession of agriculture. Gentlemen belonging to the above-mentioned classes derive most of their knowledge of the cultivators from seeing them as they appear in the Civil, Revenue and Criminal Courts of the country. Under such circumstances the cultivator is out of his element, and appears as a very ignorant and often as a perverse and stupid man. The same man in the management of his own business of agriculture may be and probably is a man of great skill, industry, and intelligence. He can do what most of his self-constituted advisers could not do, *viz.*, make a good living out of the land. His agricultural practices, rough as they may appear, are derived from the experience of generations, and cannot be presumed to be ill-adapted to their purpose, of making a living from the land till they have been carefully investigated by a trained observer. The Central Agricultural Committee and the District Agricultural Associatione contain many large land-owners, but unfortunately in this country the larger a man's landed property is, the less knowledge of agriculture does he possess and the less interest does he take in it. In the very varying conditions under which cultivation is carried on in the different parts of the Presidency even the best practical expert is quite incapable of giving any definite advice on agricultural matters *a priori*, that is to say, without some knowledge of the local conditions. As Mr. Brodie says, "in institutions like these, theorists will be of no use, nor men who take no interest in affairs, although they may own large properties. What we want are men who take a personal interest in practical agricultural matters." The Central Agricultural Committee does not contain men of this description, nor is any probability of its ever containing any number of such men. Those who are really practical men are occupied with the cultivation of their own properties and will not be found among the residents of Madras. Nor is it likely that they would come to Madras to attend the meetings of the Central Agricultural Committee.

I therefore consider that the best plan is to frankly accept the situation and wind up the Central Agricultural Committee. The District Associations may be left to reconstitute themselves under the supervision of the Agricultural Department. Most of them will probably be wound up.

Where business-like and public-spirited private individuals can be found, as at Kumbakonam, they may be encouraged to form small local associations. In other districts where the district officers have the time and inclination to lend a helping hand, these may foster the formation of small associations of practical men. As soon as such an association has been formed, it should apply to the Deputy Director of the division for help and advice. As a rule he will be able to send one of his subordinates or to go himself, and hold a meeting at which a definite programme of work for the ensuing season can be discussed. A similar meeting can be held at the end of the season, when each of the members can describe the result of his own experiments, and a fresh programme can be drawn up for the next half-year. In most cases the beginning of March and beginning of September will be suitable dates to arrange the work for the south-west and the north-east monsoons respectively. All the vernacular leaflets of the Department will be supplied free to the members of such associations. No subscriptions will be required, and the admission to membership should be rigidly restricted, so that it may be regarded as a privilege and not as a troublesome obligation undertaken to please the Revenue officers. Such Associations would cease to receive recognition from the Department if it appeared that they were not willing to work. If they work, they should form very valuable links between the Department and cultivators. I believe that there are few taluks in which half a dozen good practical men could not be found to form an association of this kind. A beginning has been made on these lines in Coimbatore and North Arcot. It should be possible before very long to have an expert agricultural adviser permanently stationed in every district, whose chief work would be to help these associations. In Tanjore there is such an adviser already, and the results there are very encouraging. In South Arcot, Tinnevelly, Malabar, and South Canara the officers attached to the Palur, Koilpatti, and Taliparamba agricultural stations have been regularly touring in the district and have introduced many improvements. When every district has its agricultural adviser and there is a small association composed of practical men in each taluk, rapid progress may be expected. But the principle of Association must be desire to work at the improvement of the local agriculture of each locality."

Matters have not moved much since that date. The Central Agricultural Committee still exists, but does no useful work. A beginning has been made in some districts in reorganising the associations on the lines suggested by Mr. Couchman.

STATEMENT.

District Agricultural Associations.	Branch Agricultural Associations.	When formed.	When affiliated with the Central Agricultural Committee.	When disaffiliated.	Condition as reported by Collectors in 1910.
1. Ganjam .	..	1906	All the District Agricultural Associations became affiliated to the Central Agricultural Committee in 1907 except Chingleput.	The District Associations of Cuddapah, Bellary, Anantapur, and Nellore were disaffiliated in 1910 for non-payment of affiliation and subscription fees due to the Committee.	Reconstituted, resolved to do practical work.
	Sompet, Parlakimedi, and Aska.	1907			
2. Vizagapatam* .	..	1905			Has had no success and is doing no good.
	Narasapatam, Anakapalle, Veeravalli, and Parvatipur.	1907			
3. Godavari .	..	1905			Meetings consist of two or three pleaders and officials.
	Rajahmundry . .	} 1906			
	Ramachandrapuram .				
	Peddapuram . .				
	Nagaram . . .				
	Amalapuram . .				
	Polavaram . .				
4. Kistna .	..	1905			Has had no part in any improvements in agriculture that have taken place.
	Narasapur . .	} 1906			
	Bapatla . . .				
	Bezwada . .				
5. Guntur .	..	1905		The Nellore District Agricultural Association has since been re-affiliated to the Central Agricultural Committee.	Has been doing some good but is not flourishing.
	Tenali . . .	1905			
	Vinukonda . .	} 1907			
	Kallikotta . .				
	Gurzala . . .				
	Sattenapalle . .	} 1906			
	Guntur . . .				
	Narsaraopet . .				
6. Nellore .	..	1905			
	Ongole . . .	1906			
7. Bellary .	..	1905			Apparently dead.
8. Cuddapah .	..	1905			Spends its time in passing resolutions but does no useful work.
9. Kurnool .	..	1905			Has relapsed into lethargy. Rarely meets.
	Pattikonda . .	1906			
10. Anantapur .	Penukonda* . .	} 1905			No use in this district.
	Anantapur . .				
	Gooty . . .				
11. Chingleput* .	..	1905			Has ceased to exist.
	Sembiam . . .	1907	Affiliated to the Central Agricultural Committee.		There is no District Agricultural Association at Chingleput.
12. North Arcot*	..	1905			Has ceased to do any work.
	Chittoor . . .	1905			
	Tirupati . . .	} 1906			
	Arni . . .				
	Sholinghur . .				
13. South Arcot	..	1906			Composed of non-agriculturists. Retards progress of agriculture.
14. Tanjore* .	..	1905			Does not show many signs of life.
	Mayavaram . .	} 1905			
	Pattukkottai . .				
	Negapatam . .				
	Mannargudi . .				
	† Kumbakonam . .				
	Tanjore . . .	1906			
15. Trichinopoly	..	1905			Has been reconstituted. Proposes to disaffiliate from Central Agricultural Committee as it gets no return for subscription.
	Kulitalai . .	} 1905			
	Musiri . . .				
	Ariyalur . .				
	Perambalur . .	1907			
16. Madura .	..	1906			Shows certain signs of activity.
	Bodinayakkanur .	} 1907			
	Dindigul . .				
	Ramnad . . .				
	Sholavandan . .				
	Melur . . .				
17. Tinnevelly .	..	1905			Moribund. Of use only for distributing leaflets.
18. Salem .	..	1905			Has no vitality.
	Namakkal . .	1908			
19. Coimbatore	..	1906			Has done nothing towards the improvement of agriculture.
20. Malabar .	..	1905			
	Malappuram* . .	} 1905			
	North Malabar* .				
	Palghat* . .				
	Calicut . . .	1906			
21. South Canara	..	1906			Working well and on the right lines. Consists largely of agriculturists.
	Mangalore . .	1905			Not flourishing.
	Puttur . . .	..			Not doing well.
	Coondapur . .	1906			

NOTE.—Where no remark appears against a Branch Agricultural Association the remark against the District Agricultural Association is to be taken as applying.

* These Associations were formed shortly before the formation of the Central Agricultural Committee in July 1905 and the remaining Associations were formed subsequently as the result of official encouragement at the instance of the Central Agricultural Committee.

† Energetic and does good work.

BENGAL.

(W. B. Heycock, I.C.S., Director of Agriculture.)

His Honour the Lieutenant-Governor inaugurated the Bengal Provincial Agricultural Association at a meeting held at Belvedere on the 26th August 1904. The object of establishing this Association was to secure the co-operation of men interested in agriculture in the dissemination of a practical knowledge of scientific methods of agriculture. The Land Revenue Member of the Board of Revenue was the *ex-officio* President and the Director of Agriculture was and is still the *ex-officio* Secretary of the Association. Leading zamindars and business men, numbering 35 at present, are its members. The Association meets at Writers' Buildings, Calcutta, where the office of the Director of Agriculture is located. A Library has been formed for the use of the members, which includes the best books of reference dealing with agricultural and industrial subjects.

Besides the Central association at Calcutta each division has an association of its own and District Agricultural Associations have been formed in all districts except Howrah, the Sonthal Parganas and Darjeeling. There are also some Branch Associations besides those at head-quarters in the districts of Birbhum, Nadia, Sambalpur and Angul. A grant of Rs. 1,000 is made annually to each Divisional Association which makes a small grant to the different districts in its division.

The Provincial Association is expected to exercise a general control over all associations in the province and to consider and advise upon questions of general agricultural importance. It is the duty of the Divisional Association to co-ordinate the work of District Associations and to serve as a convenient channel for communications. The members of District Associations are expected to take a practical part collectively and individually, both by consultation and actual demonstration work, in the improvement of agriculture in each district.

Most of the associations are still young, and it will be some time before they attain their full degree of usefulness.

One agricultural inspector is attached to each division, who is the principal agent of the Divisional Association. The chief duty of the inspectors is to visit each district in turn, to assist the members of the District Associations in drawing up their programme of work, to help them with advice and instruction regarding the use of proper implements, manures and methods of cultivation and to do all in their power to spread a knowledge of improved agriculture throughout their areas, by freely mixing with the agricultural population.

The programme of work of each association during the ensuing year is prepared at a meeting at which the divisional inspector is present. These programmes are then submitted to the Director of Agriculture, who, after consulting the Deputy Director of Agriculture, returns them to the Secretaries concerned with his remarks or approval. At the close of each year a report on the work done by each association is submitted to the Director of Agriculture. These reports are reviewed by the Director of Agriculture and his instructions are communicated to the associations for information and guidance. The programmes, however, are generally submitted so late that it is often impossible to examine and correct them before work is started. Instructions have been issued to all associations directing them to pay particular attention to the punctual submission of their programmes.

The principal mistake which almost all Associations make is to experiment rather than to demonstrate. Experiments should, in all but exceptional cases, be confined to departmental farms. After years of careful work, the Department has now certain definite recommendations to make which are placed before associations by means of leaflets or in the annual review of their work or other ways. Obviously the first work of the associations is to establish these improvements and bring them into general use. This can only be done by concentrating attention on them and by repeating them until they are finally established. Another mistake which associations make is the frequency with which they change the programmes of demonstration work. In a large proportion of cases too demonstrations are carried on on so small a scale that no general conclusions can safely be drawn from them, especially as they are not repeated year by year until they are established.

The Deputy Director of Agriculture is out of touch with the divisional inspectors. The Deputy Director of Agriculture very rarely inspects the work of the divisional inspectors and seldom, if ever, visits any of the members of the Divisional and District Associations to inspect their demonstration work. He seldom attends meetings of the District Associations and is acquainted with few, if any, of the members of these associations. In fact, he has little to do with the Divisional and District Associations, and as a consequence the divisional inspector has no expert guidance or control. The Director of Agriculture, it is true, has some idea of the work which divisional inspectors are doing, because copies of their diaries are submitted to him. A perusal of their diaries shows that the divisional inspectors do not always follow out the policy laid down by the Department, but work on lines of their own.

The failure to supervise the work of the divisional inspectors is mainly due to the fact that the Deputy Director of Agriculture has too large an area to deal with. It is now proposed to divide the province between two Deputy Directors of Agriculture and to insist on proper attention being paid to the District and Divisional Associations and to better and closer supervision being exercised over the work of divisional inspectors.

Members of associations rarely, if ever, demonstrate improved methods of cultivation alongside the ordinary methods of cultivation. The chief object of demonstration is to prove the superiority of the improvement which is being introduced. This can only be done successfully if the local variety is grown alongside the variety it is proposed to introduce. Ocular proof is wanted if the local cultivators are to be convinced.

Divisional inspectors have neglected to preach this lesson and have allowed members to experiment much as they wish. No doubt when the associations are brought into touch with this Department, members of these associations will carry on their demonstrations in the proper manner. Without the assistance of the various associations, it is almost impossible for the Department to introduce widely improved methods of cultivation.

APPENDIX E.

Subject XII:—Note on the present position of the Indian sugar industry with suggestions for its improvement.

(B. Coventry, Officiating Inspector General of Agriculture in India.)

The steady increase in the yearly imports of foreign white sugar into India combined with its low price is having upon the Indian sugar industry an effect which is reflected in the decline of the area under cane and the decrease in the number of sugar mills and refineries in the more important sugar tracts of India. It is not possible in this note to go into the details of the causes which have led to the present state of affairs, but it will be sufficient to point out that the import of foreign white sugar, which in the *quinquennial period ending 1889* was 79,638 tons is to-day over 700,000 tons per annum. Its cheapness too is such that it is not only being increasingly consumed as white sugar to the exclusion of the Indian product, but there are cases where it is being mixed with molasses and inferior *gur* and retailed as *gur*. The attention of Government was drawn to the matter by the remarks of the Hon'ble Mr. Madan Mohan Malavya at the meeting of the Legislative Council in Calcutta on 8th March 1911, and in the press and at the sittings of the Agricultural Conference held recently in Allahabad the gravity of the situation was generally admitted. It would, therefore, seem that a sufficiently strong case exists for the Government to step in and assist the industry.

2. In what way this assistance should be given is the point for determination. It is felt that the Board of Agriculture as a body is in the best position to advise Government on the policy it should adopt, and consequently *The Indian sugar industry, its improvement, and the production of refined sugar which is now being imported* has been made a subject for consideration by the Board. In order to obtain its decision as soon as possible it has been decided to hold the next meeting at Pusa towards the end of November instead of in the month of February as has been the custom. At the same time preliminary enquiries have been taken in hand with a view of aiding the deliberations of the Board and in anticipation of Government's action.

3. In the United Provinces more than half the cane of the whole of India is grown and to that province the sugar industry is vital to a degree which is non-existent in any other. Other provinces would scarcely feel the extinction of the sugar industry as they have other valuable crops to substitute for cane. In the United Provinces it is grown on a very large scale and in a considerable number of districts is a principal rent-paying crop which could not easily find an equivalent in any other crop grown there. On this account it is but proper that special consideration should be given to the wants of this province which, for the reasons detailed above, appears to feel the competition of foreign rivals in a pronounced manner. Consequently, Mr. W. H. Moreland, the Director of Agriculture, of the United Provinces, as well as Mr. A. B. Shakespear, the Manager of the Cawnpore Sugar Works, and others whose competence is well known have been freely consulted and their recommendations embodied in this note.

4. It is recognised that the problem of the production of sugar in India is a complex one. In foreign countries it may be broadly stated that the realisation of the greatest amount of sucrose (white crystalisable sugar) is the chief object in view and that all efforts at improvement whether agricultural, botanical, chemical, or mechanical are aimed at this. In India the matter is on a different footing. The production of *gur*, which is a mixture of crystalisable and uncrystalisable sugar, is the chief industry and the making of white sugar is comparatively of secondary importance. While therefore a set of appliances and a particular cane may suit the one, it does not at all follow that it will suit the other. It is therefore clear that any proposals for the amelioration of the Indian sugar industry must be dual in character. They must include the improvement and the fostering of the indigenous methods of *gur* making as well as the production of cheap white sugar. And further there is a point upon which some stress may rightly be laid, *viz.*, *that our policy should be to improve what already exists rather than attempt to create* something likely to be unsuited to the local conditions. There is a danger of persons being carried away by the idea that the central factory system with its large capital and necessary co-operation amongst growers is the one and only remedy. It may be agreed that it is certainly a thing to aim at, for it is the most perfect system of the economical making of white sugar that has yet been conceived. But apart from the fact of its being doubtful whether the central system is necessary or even suitable for *gur* making there would be grave danger in suddenly foisting these Western methods on the Indian cultivator and capitalist that they would fail as being unsuited to existing conditions and progress set back in consequence. It would be a far better course to start with the small indigenous units that now exist, adapt and improve them and gradually increase the size of these units as we find conditions, enterprise and capital are favourable. The following proposals are therefore put forward with a view of meeting the requirements indicated above.

5. It is admitted that the defects which exist in the Indian sugar industry and which hamper it in its competition with foreign rivals are :—

(1) Wrong and wasteful methods in manufacture.

(2) Imperfect cultivation by which the yield of cane per acre is low.

We are therefore able to say that the problems range themselves under two headings, *viz.*, mechanical and agricultural (to include botanical).

Among the defects in manufacture (mechanical) may be mentioned the heavy loss in the extraction of the juice owing to the low efficiency of Indian mills, the destruction of sugar due to imperfect methods of concentration and the wasteful and antiquated means of separating the molasses from the sugar in the making of the refined product. Under cultivation, which would include the botanical as well as the agricultural aspect, the defects will be best understood when it is stated that in ordinary countries 30 to 40 tons of stripped cane per acre is the usual thing, while in India 15 tons is considered good. Also as regards the quality of the cane little attention has been paid by the Indian cultivator, so that it is not uncommon to find canes yielding as low a percentage of sugar as 10 per cent. being grown when varieties yielding 17 per cent. of sugar could easily be substituted. The sum of these defects prevents India making sugar as cheap as she should and so places her at a serious disadvantage in competition with foreign countries. To remove them the following remedies are recommended :—

I.—*In manufacture.*

An expert Sugar Engineer should be appointed, and his work should be :—

A. Investigation based largely on the study of indigenous methods, to determine the best methods of extracting and concentrating the juice—

(a) to yield *gur* ;

(b) to yield white sugar—

(1) on a scale within the means of individual cultivators or small groups ;

(2) on a scale within the means of the Indian capitalists now engaged in the industry.

B. To assist in bringing these improvements to the notice of cultivators and sugar makers.

II.—*In agriculture.*

A. *Agricultural*—

(*a*) *To survey and test local varieties under chemical control.*

(*b*) To test such imported varieties as appear *primâ facie* suitable.

(*c*) To facilitate the distribution of the best varieties so determined.

(*d*) To demonstrate improved mechanical methods.

(*e*) To study questions of tillage, watering, manuring in the light of local conditions so as to increase the weight of cane per unit area.

B. *Botanical.*—The creation of a breeding station preferably in Madras in charge of a whole-time botanist principally for the production of new varieties, (*a*) by breeding and (*b*) by sports, and in addition to introduce new varieties from other sugar growing regions and to carry on in the station agricultural investigations detailed under (*a*), (*b*) and (*e*) above.

6. As regards the investigations to be carried out by the *Sugar Engineer* in the manufacturing process every consideration seems to point to the United Provinces as the more suitable locality in which to place him. It seems, necessary that his work should be localised, otherwise there is a chance of his efforts being dissipated. As already explained half the sugar of India is produced in that province, and the industry is vital to its welfare. The Agricultural Department in the United Provinces has for some time been interesting itself in the improvement of the industry and Mr. Clarke, the Agricultural Chemist at Cawnpore, *has already in hand the survey and testing of the local* varieties. The Sugar Engineer should, therefore, be placed under the Director of that province. If necessary, and his duties permit of it, he may be consulted by other provinces and allowed to visit other experiment stations. He should be engaged on a strictly temporary basis at a fee of about £750 per season and he would be required to stay in India from November to April and expected to work out during the recess season such mechanical questions as may require study in consultation with manufacturers. If an Engineer is chosen possessed of knowledge of the indigenous industry the term of appointment should in the first instance be for three seasons, while if it is found necessary to select an Engineer without Indian experience a term of five seasons is probably the best that can be recommended. He would require a first class sugar boilerman to assist him on Rs. 300—400 a month and the services of the provincial chemist. Besides some money would be required for erecting small machinery of alternative types and perhaps Rs. 50,000 would be wanted for this. Mr. Moreland has urged very strongly that the Engineer should take up his duties in the coming November; be presses this partly on account of the importance of not losing a year and partly on account of the state of public feeling in the United Provinces. If a hiatus of a season is allowed to elapse between the efforts made at the Allahabad Exhibition and the next step forward, the public is almost certain to infer that Government has given up the question. Any such impression would certainly check the movement of capital towards the industry which is just beginning in a limited and tentative fashion: whereas the vigorous step of appointing a specialist at this juncture will go far to convince the public that Government is in earnest.

As regards problems in the *agricultural* line it seems desirable *that all provincial departments should be invited* to co-operate in a combined effort to improve the agricultural aspect of the problem. The matter can be discussed at the meeting of the Board of Agriculture in November next, but it would aid the deliberations of the Board and ensure the more effectual assistance of the provinces if the Local Governments could instruct their Directors of Agriculture to come to the meeting of the Board prepared with definite proposals of the assistance they could promise to give. It is further important that the attention of the Local Governments be drawn to the necessity which exists for sugar experiment stations being set up in sugar tracts only.

There remains to consider the *botanical* work. It has been recommended that a breeding station should be set up, preferably in Madras. The botanical improvement of cane is obstructed in this country by the fact that the raising of new varieties from seed is much more difficult than in other countries, and consequently the most favourable locality should be selected for this work. This is without doubt Madras where canes have been known to arrow. It is therefore recommended that this work be entrusted to the Madras Agricultural Department, and in order to give it continuity, which is essential, an assistant botanist should be appointed. The work which would be carried on at the breeding station is best indicated in the note on "The botanical aspect of the improvement of sugarcane in India" prepared by Mr. A. Howard, the Imperial Economic Botanist, which is appended. Besides the strictly botanical work carried out at the breeding station, there will be work in the provinces attendant on the agricultural experiments indicated in a former paragraph which it is believed can be undertaken as part of the botanist's routine work and for which the appointment of whole-time men is not required. Similarly the chemical work may be considered as ancillary to the mechanical, agricultural and botanical investigations, and that the present provincial staff is sufficient.

7. To summarise the recommendations contained in this note:—

(1) The Board of Agriculture should consider the subject of the Indian sugar industry at its meeting in November, and the Government of India should invite Local Governments to join in a combined effort to improve the industry and to instruct their Directors to come to the meeting prepared with proposals of assistance, and further to draw the attention of Local Governments to the necessity which exists for *sugar experiment stations being set up in sugar tracts only.*

(2) That the appointment of a sugar Engineer being essential, he should be selected at once on terms and for a period already indicated, and that he should take up his duties in the coming November in the United Provinces without fail and that sufficient funds be apportioned for his work.

(3) That the Madras Government be invited to undertake the production of new varieties of cane by breeding and sports as well as the selection and testing of existing and new varieties and other attendant botanical and agricultural investigations at one of their stations and that an assistant botanist be appointed to aid the work.

THE BOTANICAL ASPECT OF THE IMPROVEMENT OF SUGAR CANE IN INDIA.

(A. HOWARD, M.A., A.R.C.S., F.L.S., IMPERIAL ECONOMIC BOTANIST, PUSA.)

The botanical work connected with the improvement of the sugarcane in India may be conveniently considered under the following main heads:—

I.—*The production of improved varieties.*

The fact that in ordinary cultivation this crop is always reproduced vegetatively renders the maintenance of the type a comparatively easy matter. Once a good kind is found its propagation presents none of the difficulties which attend the continued growth of many of the crops raised from seed.

Several methods of producing new and improved types are possible—(1) the introduction of new varieties from *other sugar growing regions, (2) the propagation of bud variations or "sports," and (3) the production of new seedling* varieties.

(1) *The introduction of new varieties.*—Now that it is possible to send cane cuttings by parcel post from any cane growing country to India, the introduction of new kinds is a very simple and inexpensive matter. As the introduced cuttings will *often* reach India in an enfeebled condition, care will be necessary to grow them in nurseries for the first year and to make comparisons in the field with local sorts only from the first and succeeding crops raised from Indian grown plant material. In Madras work on these lines in the past has yielded results of great value,

(2) *Bud variations or sports.*—In some varieties of sugarcane sports are comparatively frequently observed, and advantage of this occurrence is taken for the production of new varieties. Sports are naturally most easily seen in striped canes, but it is very likely that it occurs in many other canes and that its occurrence might be detected by careful observation.

(3) *Seedling canes.*—Although a very large number of seedling canes have been produced, practically nothing is known of the inheritance of characters in this crop. As a rule the method adopted is haphazard, a large number of seedlings of doubtful parentage being raised, the majority of which are discarded after an inspection of their vegetative characters in the field. To place the work on a scientific basis in India three things are necessary.

In the first place the conditions under which the flowering of the sug rcane takes place in India will have to be determined and means may have to be taken to make canes arrow. At present canes do not flower freely in India, but the proper regulation of the water-supply may increase the tendency to produce flowers.

In the second place the pollination of the various varieties should be studied in great detail; any with infertile pollen, with defective pistils or which are self-sterile should be noted. In such cases crosses can be raised easily by growing these varieties with another suitable cane in alternate rows. In this way the thin Indian canes have been used in Java to produce hybrids with one of the local canes with defective pollen. Among the resulting offspring canes with good qualities and high disease resistance have been obtained.

In the third place the inheritance of characters in the crosses made should be studied. This is likely to be a matter of great difficulty as one or both of the parents used may be heterozygotes and may *not breed true from seed.* Under these circumstances it may not be possible to say what characters will be dominant in the F_1 generation of any given cross, and possibly this generation may not always be uniform. At a modern sugarcane experiment station these matters however should receive attention and efforts should be made to place the production of new varieties on a higher plane.

The keeping qualities of sugarcane pollen should also be studied both with a view of overcoming the difficulty of crossing two kinds with different flowering periods and also of importing for hybridisation the pollen of kinds which cannot be made to flower in India.

II.—*The testing of new varieties.*

In sugarcane as in other crops one of the difficulties of handling a large number of varieties which confronts the Economic Botanist is to determine which kinds should be thrown away and which should be kept for trial on a larger scale. A safe method of elimination is required in the early stages, otherwise the work becomes impossible. Much could be done by growing the new sorts in uniform land accurately spaced with a standard known sort, say, in every tenth hole. All kinds which give a low yield of cane could at once be eliminated and the examination of the juice restricted to those of great vegetative vigour and heavy cropping power. Elimination should be continuous and only the most likely sorts kept for testing on the large scale.

III.—*Determination of the yield.*

After the preliminary tests it is necessary to carry the work of variety testing still further. The only satisfactory method of determining the yield of a variety of sugarcane is to cut the crop and make the juice into sugar. Calculations from the behaviour of the juice of small crushed samples almost invariably indicate high yields which are not subsequently realised in practice. If a whole-time officer is placed in charge of the botanical work of sugarcane improvement, it will be quite possible for him to complete the field tests.

Field tests on a suitable scale and in different parts of the same sugar tract are necessary before a new variety can be recommended with confidence. Provided only exceedingly likely sorts are considered for this work, it would be safe to enlist the co-operation of selected cultivators in obtaining a final opinion on a new variety.

In connection with these tests it seems desirable to determine the lower limit of purity of cane juice from which good *gur* can be made under local conditions. It is well known that purity of juice is of great importance in factory work and canes of low purity are useless. In *gur* making, however, where the product is not pure sucrose it is possible that juices of lower purity could be used. In this case the choice of an improved kind need not be limited to cane of the highest purity and to those most suitable for use in a factory.

This portion of the work connected with the testing of varieties involves chemical determinations. These, however, are so simple that all that is necessary is that a competent chemist should supervise the arrangement for the work at the beginning and occasionally inspect them afterwards.

IV.—*Distribution of cane cuttings.*

After the canes are tested it will be necessary to give them out to cultivators and to maintain the supply. The best method of growing canes for plant material at a sugar experiment station should be worked out and care should be taken to maintain the vegetative vigor of the best kinds. The best methods of preservation of the cuttings during transport and the most suitable methods of transport are matters which should receive attention.

Selected cultivators might find it remunerative to grow plant material in the various localities in a sugar growing tract. Everything should be done to bring this about and to make a district self-supporting as the transport of cane cuttings for long distances is a very expensive matter on account of the great weight of cane required per acre.

V.—*Conclusions.*

In the above an attempt has been made to indicate the main lines of work in the improvement of sugarcane varieties in India which could be carried out by an Economic Botanist with the necessary agricultural knowledge. It now remains to offer suggestions as to the best means of actually carrying out this work.

The production of improved canes for India need not be an expensive matter. All that is necessary is to place a whole-time officer with the requisite experience and knowledge in the most suitable province in sole charge of the work. One of the existing farms could be converted into a sugar experiment station and any necessary chemical assistance could be given. The province most suitable for the first sugar experiment station devoted to the improvement of sugarcane varieties is undoubtedly Madras where the industry is well developed and where the cultivators can command the necessary capital. Compared with this province the cultivation of cane in the Indo-Gangetic plain is somewhat primitive, while the conditions in Madras for the production of new seedlings are likely to be much more favourable than in Northern India. In addition the Government Botanist in Madras has considerable experience of sugarcane work both on the botanical and agricultural sides, and would have no difficulty in organising and conducting a sugar experiment station on the lines indicated in this note.

NOTE ON INDIAN SUGAR INDUSTRY.

(A. Shakespear, Cawnpur.)

Jaggery.—Attention has been drawn to the great variations in prices of *jaggery* throughout India. This is to some extent due to differences in quality and appearance and also to local tastes, some kinds of *gur* being very highly prized for the peculiar flavours which they possess—quite irrespective of their sucrose value. For example, there is a variety of *jaggery* made from cane juice known in the Calcutta market by the name of "Valley" *gur* which I see is selling as high as Rs. 6 per maund and high quality eating *gurs* were fetching as much as Rs. 8 per maund in cert—

markets in the Punjab quite recently. These raw sugars must be really looked upon as sweetmeats and not as raw material.

The ripening of canes.—At present the crushing season in India may be said to extend from 15th November to 15th April, but extraction is very poor with country canes in Northern India till the end of December, the varieties usually crushed during November-December are of very poor quality, and it only pays the cultivator to harvest them because he can command a fancy price for early made *gur*, corresponding to the high prices which a gardener gets for early peas, etc. Juice purities of ordinary thin varieties in normal years do not begin to touch even 70 per cent. till towards the end of December, and cannot be really said to be ripe till the 15th January (I am speaking of the United Provinces). From the conditions of the seasons I do not think it is much use attempting to get earlier ripening canes. The directions in which research should be made should be to introduce varieties which will come to maturity in April, May and June. If we could obtain a crushing season running from 15th December to 15th June, it would revolutionize costs of production for factory made sugar. The difficulty, or at least one difficulty, is that late crushing clashes with the spring cereal harvest when all available labour is required for cutting and threshing wheat and barley. Otherwise I have had experience of Hemjah cane standing as late as mid-May when it had a very remarkably high sucrose content. To keep cane in condition through the months of May and June artificial irrigation would, I think, be essential.

Raw sugar for refining.—When speaking on this subject at the conference held in Naini Tal in the year 1906 I made the following observations :—

"I compute that at least 15 per cent. of the juice could be recovered by improved milling—not by the introduction of power-mills, but by a more efficient type of the metal mill now in use, and after making allowance for the fact that as the expression is intensified, the juice becomes weaker in sugar. I believe that we should be able to recover another 1½ per cent. of sugar if we could prevent this residue of the juice passing away in the megass. My idea is that the present iron mill after it has been in use for any length of time, is little more efficient than the stone mill which it superseded. The metal of which it is made is soft, and under the action of crushing, the tendency of the rolls is to assume a slightly concave form, as the canes are not fed evenly throughout the length of the roll; this defect may be almost imperceptible, but the loss occasioned is very considerable.

"To keep the present iron mills in proper order contemplates the rolls being turned up true after each season, and this means very heavy maintenance charges. I would strongly advocate a trial being made with case hardened steel rolls. The cost of the mill would of course be considerably enhanced, but its efficiency would, I believe, be immeasurably increased and as the custom, I understand, is for a cultivator or a group of cultivators to hire the mill, the increase in initial cost would be modified. I would suggest Government communicating with the leading steel manufacturers on the subject, with the idea of importing a supply of rolls for demonstrative purpose. The field is a vast one, and I have little doubt that the steel trade would interest itself in the matter."

I still think that there must first be co-operation amongst refiners, with the object of securing a general acceptance of the principle that the *gur* must be bought on quality. Mr. Moreland, I know, tried to get the larger concerns to take the lead in bringing this about, but none of the native-owned concerns would agree. I now buy all my *gur* on a quality basis, and I find it pays me. We have very few complaints, and it is wonderful how accurately an experienced dealer will determine the sucrose content of *gur*. The Agricultural Department might endeavour to get groups of native refiners to interest themselves and at the outset provide chemical assistance to do the necessary analyses of the supplies. So long as the cultivator is paid the same, or very nearly the same, price for impure as for pure *gur*, there will be no progress towards a better state of things.

With regard to the question as to how the present practices in connection with the industry could be improved, I should like to record the following views :—

(*a*) *Mechanical.*—Something might be done in the better tempering of mill rollers ; a tremendous amount of juice is lost because, owing to the feed being always in the middle of the roller, there is a tendency for the face of the rollers to become concave. The question is greatly one of *cost*. I think the best road to an improvement in extraction would be found in a promotion of the co-operative principle in order to concentrate the crushing of the cane and so enable small *power plants* to be used with more efficient evaporating appliances, but of course one must remember that the cane cannot be carried any distance because of the labour factor. However, in the more concentrated tracts the Agricultural Department might put down a test plant for the manufacture of *jaggery* to deal with the crop off, say, 50 acres in a season of 100 days, 15,000 maunds, *i.e.*, 150 maunds per day. A careful record of results should be kept for comparison between the bullock-driven plants in the locality.

(*b*) *Agricultural.*—I think if India is not only to take her proper place amongst sugar producing countries of the world, but even to save her cane cultivation from partial extinction, she must grow a better class of cane and that all efforts on the agricultural side should be directed to this end. This, of course, contemplates better manuring and artificial irrigation, but I am quite certain that if higher yielding canes could be grown the cultivator would be able to afford to buy manures and would also be in a position to afford more generous irrigation.

(*c*) *Botanical.*—I support the recommendations set forth in the Director of Agriculture's note in connection with the establishment of a cane breeding station in the south of the country, co-ordinated with experimental farms in other important sugarcane tracts.

(*d*) *Marketing, intelligence and distribution.*—Excellent machinery already exists for the marketing of both country made raw and refined sugars, and I do not see any important directions in which improvements could be introduced. I should like something to be done to put a stop to the steadily growing practice of adulterating foreign sugars and dressing them to resemble the country made product, but I do not see how the State can very well intervene. Nobody wishes to discredit imported sugars in any way, but there is a sentimental value attaching to country made sugars amongst a large portion of the population, and if a man is prepared to pay a higher price for these, he s justified in getting them.

Extension of sugarcane cultivation.—There are immense possibilities for extending the area sown with sugarcane provided a better quality cane can be produced, but unless this is possible, I think the tendency will be steadily towards a decrease of cultivation, as there is no doubt that the higher grades of Indian raw sugars are gradually being replaced by cheaper refined sugars from abroad. An alteration in the system of land tenure would of course change the whole aspect of the industry, but I think it is extremely unlikely that Government would do anything to disturb the rights of occupancy which are now enjoyed by the Indian cultivator. Much of the success attained in certain sugar producing countries has undoubtedly been due to concentration of cultivation, and there is no question that if land could be put under this crop in large blocks, many of the difficulties confronting the establishment of a central factory system would disappear. I do not think, however, that it is any good going into this question further, because I feel convinced that Government would never permit any alteration in existing conditions. An important point in connection with the more extended use of manure is the restrictive character of present day railway freights. I have repeatedly endeavoured to obtain acceptance of the principle that on broad economic grounds manure should be carried by railway companies at net working costs, I think Government would be well advised to take up this matter.

In connection with the appointment of what the Director describes as a sugar Engineer, I think what is wanted is rather a sugar chemist with a general practical knowledge of machinery and mechanical methods. To be of value in connection with improvements in the manufacture of raw sugar, such a man must have a thorough working knowledge of manufacturing methods and sugar technology, and it will also be of great assistance to him if he is a professional chemist, because in all his investigations a constant checking of results by analysis will be necessary. The mechanical knowledge required would be of a simple character, as he could always refer mechanical questions to Engineering Companies; an Engineer pure and simple would however find himself handicapped in many directions.

From Mr. W. Neilson, Manager of the Factory at Nellikuppam, to Director of Agriculture, Madras.

In submitting the note which you asked for on this interesting subject, I would ask permission to review the matters under reference in a somewhat different order than they are in the list which you have submitted.

The first question I will attempt to answer is :—

"Is the production of *gur* or *jaggery* for consumption as *gur* or *jaggery* a different problem to its production as a basis of white sugar ?"

I should say in reply to this that the problem is a different one. The production of *gur* or *jaggery* for consumption is a problem of producing a light coloured and good flavoured material not necessarily with a very high standard as far as sucrose is concerned. The *gur* produced as a basis for refining must of necessity have a high sucrose content and be of stable chemical composition, and this stable composition can only be obtained by the use of larger quantities of lime in its manufacture than in the case of *gur* for direct consumption. The larger quantities of lime used in the manufacture will help its stability, but will rob it of some of its attractive qualities of colour and flavour, as far as the consumer is concerned. Further, in the agricultural side of the matter the same objects must be held in view. For direct consumption of *gur* a cane yielding largely per acre, with a juice of good colour and moderate co-efficient of purity, is the ideal. The *high purity* of the juice of the cane for producing *gur* for refining is the essential.

The problem however is not so essentially different that it would be impossible with the same plant to turn out *gur* for direct consumption or *gur* for refining.

I would venture to say that the existing practice cannot be much improved unless a certain amount of centralisation in the manufacture is established. Factories dealing with about 500 acres of cane would I think be a sufficiently satisfactory basis on which to work *gur* manufacture. Such factories would necessarily require to be equipped with the most modern crushing plant, best boiler equipment possible and a satisfactory evaporating plant for making special refining *gur* or *gur* for direct consumption. Regarding the mills and boilers there is no difficulty whatever. A satisfactory evaporating plant for producing *gur* has yet I think to be introduced into India. The old Fryer's concretor is very satisfactory in its results as far as quick evaporation is concerned, but I am doubtful if it could effect a complete defecation and evaporation of the juice without fuel beyond that supplied by the cane. I understand there is a new apparatus on the market which has been installed with satisfactory results in Formosa for making Chinese sugar which is an analogous product to the *gur*, the manufacture of which I have been discussing. I think on the whole mechanical difficulties present very little obstacle to the success of such enterprises. The chief difficulty is on the agricultural side. To compete with Java—the most dangerous competitor of the Indian sugar industry—the agriculturist must produce a crop of at least 40 tons per acre of cane of 85 purity and he must produce the same at a cost of Rs. 250 per acre delivered at factory. The cost of transporting cane to the factory in India, in our district at any rate, bears a very favourable comparison with the cost of transport in Java, although Java factories are very much better equipped than we are in the matter of light railways, bullock traction or rails and steam tramways. The advantages such a small central factory would offer beyond the existing system of independent crushing to the individual ryot are the following :—

(1) Modern mills will give an extraction of 81 per cent. of juice as against the 68 per cent. got by the ryot. The difference in the extraction would be pure profit to him.

(2) He would get this work of evaporation done entirely by the megass from the cane without collecting extra fuel which in many districts is scarce, and I think his market would be a readier one than it is at present. I would remark however here that as quality in the product supplied to the factory is highly essential, I consider that it is absolutely necessary in the case of the manufacture of *gur* for refining and of white sugar that the manufacturers and planters be *the same individuals*. Otherwise there is so little control over the quality and condition of the cane supplied that serious losses are likely to ensue if the planter insists on supplying under-ripe or over-ripe cane or is careless in the harvesting of his crop.

(3) The quality of his product would be much better.

Many of the above remarks apply to the manufacture of white sugar as well as to *gur* for consumption and refining *gur*. To more fully explain my ideas on the subject of white sugar making I would sketch what I consider the ideal conditions of a factory suitable for India :—

1st.—A district favourably situated in the matter of soil and irrigation facilities and a good supply of water for the factory. Proximity to railway communication is also desirable. A good supply of lime in the district is necessary.

2nd.—Certainty that good cane of high purity can be grown in the district. This is not at all difficult to ascertain.

3rd.—A modern white sugar factory capable of dealing with about 500 tons of cane per day fitted with the most modern quadruple crushing installation. Quadruple evaporators and the usual accessories installed in the modern *Double Carbonatation Process Factory*.

Such a factory would deal with 1,500 acres of canes in 4 months and would require to be located in a district in which within a radius of six miles of the factory there is an area of 6,000 acres suitable for growing cane.

I have no doubt that throughout the length and breadth of India there are very many such districts, and I have every confidence that if a factory of the indicated description were erected under the conditions I have described, it would prove a very great financial success. I think a 1,500 acres factory is the ideal unit for a white sugar factory, and the most modern and most successful factory in Java is one of that description. Cane even in the hottest districts of India can with reasonable care be transported even with the most primitive traction with safety the distance I have mentioned, and in many successful Java factories cane is brought from considerably further afield.

In conclusion, I would say if the sugar industry is to be re-habilitated attempts such as I have described in the direction of white sugar factories must be made. All efforts at improving the indigenous industry in the matter of improved processes in the manufacture of *jaggery* for consumption and refining may to some extent delay the decadence of the industry, but I think the sole hope is the establishment of such factories for white sugar making as I have just briefly sketched. There is no doubt that it might be possible once such a white sugar factory were established, to supplement it by a subsidiary industry of refining *gur* made by the improved processes I have indicated ; but I think the first step must be the establishment of an up-to-date factory making white sugar from the cane in its immediate neighbourhood.

The only Government assistance which I think would be necessary is the granting of a license for cane growing in particular districts of which Government approve and the prohibition of the manufacture of *jaggery* or sugar of any description in that district except by the licensee. Some protection for these infant industries would also be desirable for a limited period until they have been established. Government assistance in obtaining leases from the land owners in the selected districts might also be helpful.

NOTE ON THE SUGAR INDUSTRY IN THE CENTRAL PROVINCES.

(C. E. Low, C.I.E., I.C.S., Director of Agriculture.)

In stating what share we propose that these provinces should take in the effort now to be made to improve the state of the sugar industry over India as a whole, it is necessary to trace very shortly the history of the cultivation of sugar in the Central Provinces since the provinces first came under British rule.

The area under cane in 1885-86, excluding Sambalpur, was 42,551 acres. The area is at present (1910-11), excluding Berar, 19,463 acres. The imports of sugar by rail for the quinquennia, 1880-85, 1890-95, 1900-05, 1905-10 were—

Years.	Refined *in maunds.*	Unrefined *in maunds.*	Total *in maunds.*
1880-85	106,103	385,222	491,325
1890-95	126,155	490,387	616,542
1900-05	336,844	734,220	1,071,065
1905-10	610,316	1,059,300	1,669,616

Speaking generally, cane was originally grown in every district to supply local needs. As communications improved its cultivation became more and more confined to the areas where the best facilities for cane cultivation exist. The United Provinces and the Poona tract at present are the chief sources of supply for *gur*, but there has also been a very large increase in the consumption of refined sugar. People who once ate *gur* now eat refined sugar, and others who seldom indulged in such luxuries at all now eat *gur*. The consumption of *gur* has not fallen off much, though it has not expanded as it would have done but for the increased use of refined sugar. This may be seen from the figures below, giving the imports of sugar (refined and unrefined) into towns levying octroi in the Central Provinces. Up to a certain period the refined and unrefined sugar were shown together under one head. Figures for gross imports, *i.e.*, including quantities re-exported are only available for recent years, so that it is only for these few years that the consumption in the local areas served by the towns can be traced.

Years.	Refined Net imports, *i.e.*, total quantity less amount on which refunds have been allowed. *In maunds.*	Unrefined Net imports, *i.e.*, total quantity taxed, less amount on which refund has been allowed. *In maunds.*	Remarks.
1880-81	..	..	
1881-82	..	..	
1882-83	..	..	
1883-84	274,380	..	(a) Net imports of sugar, saccharine produce and honey.
1884-85	223,119	..	
1890-91	253,665	..	
1891-92	230,901	..	(b) Manufactured or refined sugar and honey.
1892-93	204,407 (a)	..	
1893-94	246,534 (a)	..	
1894-95	68,551 (b)	96,895 (c)	(c) Gur and other coarse saccharine products
1900-01	119,728 (d)	216,484 (f)	
1901-02	109,922 (d)	120,203 (f)	
1902-03	96,952 (d)	130,620 (f)	(d) Manufactured or refined sugar.
1903-04	141,737 (d)	149,958 (f)	
1904-05	124,317 (d)	210,444 (f)	
1905-06	158,476	192,531	(f) Gur and other saccharine products.
1906-07	152,350	139,813	
1907-08	142,172	125,084	
1908-09	143,532	118,742	
1909-10	152,081	173,630	

It seems a warrantable conclusion that the consumption of refined sugar is likely to go on increasing indefinitely, but that the use of *gur* will probably maintain itself more or less as it is for many years to come.

Assuming that it is desirable to have central factories before we can fully exploit the production of sugar that might be attained in India with improved cultivation and organisation, there seems no reason to apprehend that, while this increased area is being built up in any locality, there will not be a demand for the increasing supply of *gur* that will be produced in the meantime.

The question has only become an important one in the Central Provinces since the results of our irrigation policy have become manifest. It is probable that by twenty years from now we shall have some seven or eight hundred thousand acres under permanent irrigation. In order fully to make use of the water facilities so provided, and to pay interest on the prime cost of the works, it is necessary to encourage the growth of cane as well as of other superior crops.

I now proceed to show what is the policy we are following.

These large irrigable areas are mostly confined to the Chhattisgarh, Wainganga and Jubbulpore tracts, which are also at any rate, with the exception of the last named, the most important remaining sugarcane areas.

We have a farm at Raipur where an area of 30 acres suitable for cane exists. This can be irrigated by lift from a *nala* with a permanent water supply: it will ultimately be commanded by one of the largest of the new irrigation works and will serve as the sugar centre of the Chhattisgarh tract. We are starting a large farm at Chanda, at a village called Garmsuai, where permanent irrigation can be secured over a considerable area from a large private tank. This will be the centre for the work in the Wainganga area, supplemented by the small farm recently started at Tharsa in the area commanded by the Ramtek tank. This will supply the 40,000 acres commanded where it is not likely that cane will be quite so extensively grown as in Chanda.

For the use of the Economic Botanist and of the Deputy Director in charge of the Southern Circle, where most of the sugarcane work will lie, there is the Telinkheri Farm, adjoining Nagpur, where irrigation is available, even if the soil is not the best that could be desired. For Jubbulpore a farm is shortly to be started; this is also commanded by a large tank.

At these farms we propose to conduct a series of manurial, cultural and other experiments, to grow seed and to store machinery so long as may be necessary.

Generally speaking, we recognise that the Provincial Department is new to the work of growing cane, and we shall follow in the steps of the larger cane growing provinces, adapting their results after due experiment to local conditions, rather than attempting to strike out new lines for ourselves. But Central Provinces conditions are

decidedly different from those existing in the other cane growing tracts of this country, and it is probable that the results attained there will require considerable modification in matters of detail, to make them suitable for adoption here. It is only a few years since the Department took up sugarcane work at all and there is much to be done before we can consider ourselves as possessing a satisfactory acquaintance with the subject.

A good deal of work is required, in the first place, in cultural experiments, to discover the most suitable local methods. The system of irrigation and drainage practised in the Nellikuppam factory is now being tried on our farms for the first time.

We have laid down some time back series to test the kinds of manures locally available, and additions have been made to these, after consultation with the managers of the various local oil mills. These at present find it somewhat difficult to get a market locally for their cake.

We are testing varieties, and have made up our minds as to the general lines to be followed for the present in introducing these to the people. But considerable experiment will be needed in the future to extend the harvesting period of the cane areas as long as possible, if central factories are to be successfully worked in the Central Provinces. Demonstration plots have been started, and there are at present 17 in Chanda and 14 in the Upper Wainganga area; these will be steadily increased and we propose to increase the staff in these tracts as far as our resources allow. About 70,000 seed canes of the best varieties were distributed from the Raipur and Telinkheri Farms this year.

Minor difficulties that will have to be taken up are, the cheapening of the fencing and propping of cane, and the destruction of wild animals which are likely to be a serious drawback to the growth of cane in the Wainganga tract. We have not had much practical experience of these yet, but shall probably be better acquainted with them after a few years' experience of the working of our farm in the Chanda district. The ratooning of their canes is very seldom practised by local cultivators: considering how free the province has been from red rot, it may be possible to extend this practice. The growing of bamboos, *Sesbania grandiflora*, etc., as wind breaks is being introduced experimentally on our stations.

One of the drawbacks to the extended cultivation of cane is undoubtedly the bad finance of agriculture generally. Especially is this the case in the tracts now for the first time protected by irrigation. In order to help the beginnings of the industry in these areas, a scheme has been sanctioned by the Local Government, whereby the Department will advance seed, to be repaid in kind at the end of the harvest, manure at cost price, to be repaid in cash, and a small amount of cash to meet other necessary expenses of cultivation. These advances will be under the Agriculturists'' Loans Act, but the Department will not charge itself with the collection and marketing of the *gur*, though it will hire out mills and assist the cultivators in every way to get a good price for their product.

In addition to the above, the Local Administration have agreed to the reservation of 3,000 acres of suitable waste land, surrounded by villages where small quantities of cane are even at present cultivated, the whole protected by a large irrigation work, and conveniently accessible by road and rail, in the hopes of inducing some capitalist to come forward and start a central factory there. This offer will be kept open for a certain number of years. The Department will in the meantime make every effort to spread the cultivation of cane in the neighbourhood. It is hoped that this nucleus area, which is entirely free from all rights of every description, will overcome the difficulty which the state of the tenancy law in most parts of India is said to present. Most of the area under cultivation in the Central Provinces is held by small tenant proprietors, who can be very well held to any contracts entered into by them for producing cane, especially if such be entered into with the assistance of the landlords, but the state of the law does not admit of their transferring their holdings without great difficulty and uncertainty.

Finally, the price of *gur* is so high, that any scheme dependent on the supply of cheap *gur* is bound to fail. For this reason the Hadi process is not suitable for the Central Provinces, and it will be necessary, before a central factory can succeed, to increase the area of cane grown locally, in order to bring down the price of *gur*. Nine annas a maund is about the lowest price at which it was found that cultivators in Chanda at any rate were ready to part with their green cane.

EXTRACT FROM A BOOK NOW IN THE PRESS ON RURAL ECONOMY IN THE DECCAN.

(G. F. Keatinge, I.C.S., Director of Agriculture, Bombay Presidency, Poona.)

"In the Deccan there are about 35,000 acres under sugarcane, producing 90,000 tons of raw sugar valued at Rs. 2 crores. As against this local production there is an import of nearly 20,000 tons of foreign refined sugar, mainly from Java and Mauritius. It is sometimes argued that since India can produce sugar it ought to be encouraged to produce all the sugar that it requires, and that the necessary stimulus would be given if an import duty were placed on refined sugar. Now it has already been pointed out that under existing circumstances sugarcane cultivation is a most profitable industry, and admits of large profits being made. Granted a reasonable amount of capital and a moderate amount of skill, a net profit of Rs. 200 per acre can be obtained. Perennial irrigation is in the Deccan essential to sugarcane growing, and it is the lack of such facilities that limits the area under this crop. Lack of capital also is another determining factor in the case; for the crop is one which requires much capital per acre planted. Unless more water and more capital can be made available, more cane cannot be grown except to a small extent at the expense of fruit, vegetables and other garden crops; and there would be no object in stimulating sugar production at the expense of other valuable crops which are needed for local consumption.

"It may be argued that if prices were enhanced by means of protective duties more capital would be attracted into the business of cane growing, and more wells would be dug. After what has been said regarding the great advantages derived from irrigation wells the idea of encouraging the construction of new wells by this means may appear attractive; but a consideration of the facts will show that it is very doubtful whether any marked result could be obtained by this means. The following table shows the condition of the sugar industry and trade in the Deccan in recent years.

"Area under sugarcane in the Deccan, its outturn, trade in sugar and prices of sugar and *gul*, etc.

1	2	3	4	5	6	7
Year.	Area of sugarcane in the Deccan.	Outturn in Tons.	Value of the *gul* produced.	Imports of foreign sugar into the Deccan.	Price per ton of sugar.	Price per ton of *gul*.
	Acres.	Tons.	Rs.	Tons.	Rs. a. p.	Rs. a. p.
1899-1900	42,095	120,572	19,078,003	6,922	227 2 2	158 8 8
1900-1901	20,961	49,127	8,873,820	11,518	234 12 8	180 10 1
1901-1902	30,012	65,963	18,841,120	12,521	227 6 9	219 2 10
1902-1903	32,320	93,298	12,438,400	10,188	209 15 8	133 5 4
1903-1904	33,270	95,294	16,166,579	14,313	206 3 7	169 7 0
1904-1905	33,694	96,609	21,360,659	13,031	221 2 11	221 5 6
1905-1906	34,706	99,408	19,344,925	17,419	211 1 3	195 12 10
1906-1907	31,803	91,093	16,814,250	17,480	167 0 0	185 9 4
1907-1908	33,689	82,663	17,193,904	17,001	188 6 10	208 0 0
1908-1909	35,831	87,152	17,352,780	16,914	200 12 3	199 1 9
1909-1910	34,728	93,132	20,598,684	19,963	211 1 10	212 11 7

"It will be seen from columns 2 and 3 that the sugarcane industry received a severe check from the famine of 1899-1900 which caused the area and outturn in 1900-01 to fall to less than half their previous figures. This result was mainly due to temporary shortness of irrigation water. The effects of the famine, however, continued to be felt long after the water supply had righted itself, and the production of sugar, though it shows an upward tendency, has not yet reached its old level. This is due to shortness of capital, which is a normal complaint in the Deccan and is intensified by bad seasons. Column 5 shows that the falling off in local production has been made up, to some extent, by increased imports of foreign sugar. Column 7 shows that, excluding the year 1901-02 when the high price of *gul* was a scarcity price caused by the short production of the year before, the price of *gul* during the last six years has been 25 per cent. higher than the previous average. This is due mainly to the increased demand for *gul* on the part of the cotton cultivators. The increase of price, however, has not served to stimulate in any marked way the production of sugar, which is limited by the supply of irrigation water and capital available. The price of *gul* is already sufficiently remunerative, and nothing would be gained by increasing the profits of the cane-growers, by means of an import duty, at the expense of their less fortunate brethren who have no facilities for irrigation. If it is desired to stimulate cane growing the best means is to increase the facilities for irrigation and to organize agricultural credit. The measures that are being taken in these directions have already been described.

"So far we have dealt only with sugar *in general*. The question whether it is more profitable to produce raw sugar or refined sugar is quite distinct. It appears to be sometimes thought that there is some special virtue in producing refined sugar, and that an effort ought to be made in this direction. A consideration of the figures in columns 6 and 7 in the above table will show that during the last six years the average price of *gul* (raw sugar) has been higher than the price of refined sugar. This being so, there is obviously no object in undertaking a costly operation which will not only *reduce the quantity of sugar produced by 25* per cent.*, but which will actually reduce the value per ton of what is left. The people in the Deccan prefer *gul* to refined sugar; and at present prices there is absolutely no opening for sugar-refining in this part of India. It does not follow, however, that because there is now no opening for sugar-refining in the Deccan, there never will be an opening. On the contrary, *there are several considerations that make it doubtful whether the profits of producing raw sugar will be maintained* for long at their present level. In the first place it is possible that the taste for *gul* may decline and the taste for refined sugar increase. In other parts of India sugar is consumed in preference to *gul*, and there is no doubt that in the Deccan some classes are beginning to use sugar in a way that they did not do a few years ago. If this tendency increases greatly the price of *gul* must fall. Further it is quite likely that the continuous improvement in the process *of sugar manufacture which is being made in other countries will tend to lower the price of refined sugar. As this* occurs it will stimulate the tendency to substitute the use of sugar for that of *gul*.

*In refining sugar about 25 per cent. of the raw article is separated out in the form of molasses.

"Moreover while the demand for *gul* may possibly fall off in the near future, the supply is certain to increase when the new irrigation canals now under construction are in full working order. Thus, with an increased supply and a decreased demand, the price of *gul* may fall to a level at which it will be much less remunerative to the cane-grower. In this case it will be possible to maintain the sugarcane cultivation in the Deccan only by refining sugar; and the refining business can be conducted with profit only by means of the most up-to-date machinery and organisation, such as have been adopted by Java, Mauritius and the other countries which now flood India with refined sugar. The purchase and erection of the machinery is a matter of capital. The provision of the capital might present some difficulty; but at any rate the difficulty would be a straightforward one. The difficulty of organisation would be far more complex since it involves placing on a capitalistic basis the operations of a large number of small cane-growers co-ordinating the cultivation of a large area of cane, and concentrating the whole business on a central factory."

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